MARKHAM

ON

SPANISH IRRIGATION.

REPORT

ON THE

IRRIGATION OF EASTERN SPAIN.

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ON THE

IRRIGATION OF EASTERN SPAIN.

I.

INTRODUCTORY.

An account of the works of irrigation, of the rules and customs by which the distribution of water is regulated, and of the agricultural condition of the irrigated land, in any country where irrigation has long been practised, cannot fail to be interesting, and may probably be useful in India, at a time when the subject of irrigation so urgently demands attention. Colonel Baird Smith's work on Italian irrigation supplies such information, so far as the works in the valley of the Po, and the systems in use in Piedmont and Lombardy are concerned. He introduces his subject by pointing out the striking similarity between the natural features of Northern Italy and Northern India. Both are situated at the bases of great mountain ranges, both are drained by rivers flowing from regions of perpetual snow, and both have other features with the same

leading characteristics. It is curious, too, that the construction of the first great irrigation canals is contemporaneous in Northern India and Northern Italy. The canal of the Shah Feroze in India, and that of Gattinara in Piedmont, were both commenced in the fourteenth century.

If the irrigated region of Northern Italy may thus be compared with that of Northern India, the eastern coast of Spain may, with equal propriety, be compared with the eastern side of the Indian peninsula. Both in Eastern Spain and in the Carnatic the rivers rise in mountains below the level of perpetual snow, and are deficient in that permanency and regularity of supply which is the characteristic of more favoured irrigated regions. In both countries the rainfall is scanty and precarious, and the dry crops which are dependent upon it often fail. In both the supplies of water for irrigation are secured by similar contrivances. The works in Italy and Spain are, of course, on a much smaller scale than those of Northern India and the Madras Presidency.

In the North-Western Provinces and in the Punjab, the great works of irrigation are nearly all due to the English* ; but in the Madras Presidency, which is the part of India most analogous to Eastern Spain, they are almost entirely of native origin. The important works at the deltas of some of the rivers, and the unfinished

* For the canals of Shah Feroze and Shah Jehan were intended rather to supply the palaces and pleasure grounds of those sovereigns, than to furnish irrigation to the fields of their subjects.

canal from Kurnool to Cuddapah, are English. But the whole system of canals and anicuts for irrigating Tinnevelly, all the works in Madura, the original works on the Coleroon and Cauvery for the irrigation of Tanjore, and the thousands of tanks throughout the Presidency, are of purely native origin, and of great antiquity. Centuries of experience had taught the ryots and wudders an extraordinary amount of engineering skill and administrative aptitude in the management of these works. English engineers may even now learn much, as regards tank engineering, from many a half naked maistry of the tank digging caste, and the old native method of distributing water is acknowledged to be superior to any system which has yet been devised for the irrigation works of English origin.

It is, therefore, to be expected that some useful hints should be derived by public works officers from a people who have from necessity, and from time immemorial, been dependent on irrigation for the ripening of their crops. Undoubtedly this is the case in India. It seemed probable that in Spain, where irrigation has been practised for many centuries, there might also be something to learn ; and that information collected in the Spanish irrigated gardens would prove useful, even if, in a professional point of view, it should serve no higher purpose than to act as an incentive for further inquiry.

In the hope that the present Report may be the means of drawing the attention of public works officers to this field of professional inquiry, I have appended a

bibliographical list of all the sources of information which came to my knowledge, bearing upon Spanish irrigation, and on the topography of the irrigated districts.

MAP SHOWING

THE IRRIGATED DISTRICTS

OF

EASTERN SPAIN

Reference

1 Garden of Murcia
2 " " Orihuela
3 Irrigation round Crevillente
4 Tank Irrigation of Elche
5 " " of Alicante
6 Garden of Novelda
7 " " Gandia
8 " " Jativa
9 Irrigation from the Xucar
10 Garden of Valencia
11 " " Castellon
12 Bell Irrigation of Vinaros & Benicarlo

English Miles

II.

MOORISH ORIGIN OF WORKS OF IRRIGATION IN EASTERN SPAIN.

THE works of irrigation in Spain, which it is the object of this Report to describe, are to be met with along the eastern coast from Cartagena to the mouth of the Ebro, in the old Arab kingdoms of Murcia and Valencia. They all owe their origin, and the rules and customs by which they are managed, to the ancient Arab rulers of the peninsula, and have been in working order for upwards of a thousand years; though, in some instances, they have been enlarged and improved in more modern times. It is probable that there were some few irrigation works in this region, even in the time of the Romans, when Spanish agriculture was represented by Lucius Columella; but this is uncertain, and to the Spanish Arabs the credit is due of having instituted a system whereby the rocky deserts and dried-up valleys of the peninsula were converted into terraced gardens and fertile *vegas*. The Government of the Caliphs of Cordova, so far as its Public Works Department was concerned, was certainly the

most efficient that has ever existed in the world, with possibly the single exception of that of the Yncas of Peru; and to the long period of peace and prosperity which was secured to this part of Spain by the firm and beneficent rule of the Ommiad Caliphs, is to be referred the execution of the great works of irrigation in Murcia and Valencia. Some of these works are actually ascribed to particular reigns, and there can be little doubt that all date their origin from this period—about A.D. 760 to 960 The subsequent centuries of Arab domination were periods of strife and internal dissension, ending in a struggle for existence. Those were not times for originating public works,* though

* I allude to the state of affairs in Valencia, Murcia, and the outlying parts of Mohammedan Spain during the last few centuries of Arab sway. The kingdom of Granada, which was founded at the very time when the other Mohammedan kingdoms were falling under the yoke of the encroaching Christians, survived for two centuries, and in that favoured region the mining and irrigation works of the Arabs continued to be pushed forward with vigour and intelligence But I do not propose to dwell in detail upon the irrigation works of Granada, because they do not present the same interesting series of local rules and customs which are met with in connection with the more ancient systems established in Murcia and Valencia In Granada irrigation was the work of the State, while the chief object of the water supply system in that kingdom was to feed the fountains and baths of the capital A very brief account of these works will be sufficient The Arabs conducted four canals from the river Xenil, and three from the Darro, which irrigated the *vega* and supplied the city of Granada with water The main canals brought the water to large reservoirs, called *albercones*, within the city, whence it was distributed by a thousand small channels to the palaces and houses, the gardens, fountains, and public baths. Sewers were also con-

the irrigation system that had been instituted in the days of the Caliphs was perpetuated and confirmed under the succeeding dynasties, until, when the Christian conquerors appeared in the thirteenth century, it recommended itself for adoption, backed by the experienced benefits of five hundred years

The old Arab systems of irrigation are to be met with in the *huertas* of Eastern Spain to this day, and will be fully described further on. The Spanish conquerors, far less civilised than their defeated foes, could, at the best, merely follow in the footsteps of the Arabs. But the enlightened subjects of the Western Caliphs had brought the science of irrigation, and, indeed, of all branches of agriculture to the highest perfection. The bare enumeration of Arab authors on

structed to carry off the water after it had been used. The water of the canals which supplied the city was allowed to be used for irrigation during certain hours of the day, while at night, when the water was coolest, it was exclusively reserved for the supply of Granada. The other canals fertilised the *vega*, and served as the motive power for 130 mills. These works were constructed by Mohammed Alhamar, the founder of the kingdom of Granada (who reigned from 1242 to 1273), and his successors, with the general revenues of the State, derived from royal fifths, *almojarife* or customs duties, *alcabala* or tax on transfers of property, *azake* or tithes, and *tahadil* or composition for duties on shops and houses. After the conquest, Ferdinand and Isabella granted the free use of the water in these canals to the new settlers in the *vega*, in the *Cartas Pueblas* or charters conceding special privileges, and Charles V issued an elaborate Ordinance in 1538, in which the duties of officers connected with the water works are stated in detail, and rules are laid down for the distribution of the water.

these subjects would fill a volume, though only one has been brought within the reach of modern students. The work of Ebn el Awran, translated into Spanish by Banqueri,* gives some idea of the advancement of the Arabs of Spain in agricultural knowledge generally; but the *Almokna* or recollections of the best principles of agriculture by Abu-Omar, the work of Abu-Abdalac, who wrote with a knowledge acquired by cultivating his own estates with his own hands, that of the learned Abu-el-Jair, and many others, are still hidden from us in their original Arabic manuscripts. Schools of agriculture were instituted in Cordova, Seville, and other large towns; and irrigation works were constructed and ordered on principles which were sound and practical It was well understood that water, to be made useful to the community, must not and could not be regarded as the private property of the owners of land through which it flowed; but that it was the joint property of the whole of the inhabitants, to be regulated for the general good.

How little either the Castilians or Aragonese were worthy of succeeding the Arabs in the government of the irrigated valleys, will be seen by a brief glance at the course of their legislation previous to the middle of the thirteenth century, when the gardens of Valencia and Murcia fell into their hands. The earliest Spanish laws are contained in the code of the Visigoths, gene-

* Published in the beginning of the present century, by order of the Spanish Government, with parallel Arabic and Spanish columns. There is a French translation, but without the Arabic text, in the British Museum, by Clement Mulet.

rally called the *Fuero Juzgo*, by which two-thirds of the produce of all land was reserved for the conquering Goths, and one-third for the aboriginal Spaniards So far as it relates to property in land, and in the water of rivers and streams, the *Fuero Juzgo* is nothing more than a body of penal laws for the protection of the acquired rights of the Goths. When the Spaniards began to issue from the Asturian mountains, and commenced the long struggle for the dominion of the peninsula, their legislation consisted in little more than rough laws for the distribution of booty and of the conquered land. After the king had received his fifths, the remainder was divided amongst the chiefs, according to the number of their followers, the *enchas* or compensations for the killed and wounded having been duly set apart.* It soon became necessary to grant special privileges to settlers who established themselves in the frontier towns, and were obliged to till the ground with arms constantly in their hands. Hence the *Cartas Pueblas* or *Fueros Municipales*, which are very numerous, and in some of those of later date the proprietary right over the water of streams is granted to the inhabitants as a body. But, on the other hand,

* The Arabs made a similar distribution of spoils. In 963 A D., the Caliph Alhakem published the following proclamation at Toledo "It is the duty of every good Moslem to serve in the *Algihed* You shall not kill unarmed women nor children, nor monks who live a secluded life. All the spoils, after the fifth has been set apart for our use, shall be divided on the field of battle. A knight shall receive two shares, and a foot soldier one share. You may take what you require of provisions and things to eat," etc. etc.

the *Fuero Viejo de Castilla*, a code which was drawn up by the order of Alonzo VIII. in the beginning of the thirteenth century, gives no sign of any idea that running water in streams and rivers should be the property of the crown or of the public, in regions where irrigation is a necessity. On the contrary it protects the rights of private proprietors by the imposition of fines and other punishments.

The first improvement in Spanish legislation, as regards the use of water required for irrigation or navigation, appears in the reign of that learned sovereign, Alonzo the Wise. He promulgated the laws embodied in the *Fuero Real* in 1254, in which all navigable rivers are declared to be free for the use of all members of the community (*Lib* 4°, *Ley* 6ª), and at the same time he was himself engaged in the preparation of the famous *Siete Partidas;* which were not, however, ratified until the meeting of the Cortes of Alcala in 1348. Alonzo was far in advance of his age; he was not only a very learned, but a judicious and practical man,* and his *Siete Partidas*, which display a knowledge of the true principles of legislation that would be looked for in vain in any other country at the same period, have justly received the title of the Castilian

* His unwise desire to be crowned Emperor of Germany, and his fondness for astronomy, have been dwelt upon to show that he was a vain and unpractical ruler; but the *Siete Partidas*, and the wisdom of the measures he adopted to preserve the Arab works of irrigation in Murcia, are not the only proofs that he possessed qualities of the highest order, both as a legislator and an administrator.

Pandects. In the *Siete Partidas* it is declared that all rivers, harbours, and high roads belong to the community at large, and no distinction is made between navigable and un-navigable streams.* This great principle, entirely opposed to the strict proprietary rights established by the *Fuero Juzgo* and the older Castilian laws, is the same as that which had long been recognised by the Arabs, and without which any extensive system of irrigation would be impossible. The western Caliphs had long ago declared that running water was the property of the community at large, and not, as was held by the feudal Spaniards, of the proprietors through whose land it happened to flow.

Fortunately for the irrigated plains of Valencia and Murcia, those kingdoms were conquered, in the middle of the thirteenth century, by wise and enlightened sovereigns; and, instead of introducing the barbarous feudal laws which were then in force in Aragon and Castile, James the Conqueror and Alonzo the Wise confirmed the ancient rules and customs of the more civilised Arabs, especially those relating to irrigation, and granted the proprietary right in all the channels and works to the inhabitants.†

* *Ley* 6ª, *Tit* 28, *Part* 3ª.

† The grant of James I. of Aragon, dated May 8th, 1268, was afterwards embodied in the *Fuero* (laws) of the kingdom of Valencia, *Lib. iii*, *Fuero* 35 It runs as follows:—" For us and our successors we give and concede for ever to you and each one of the inhabitants of the city and kingdom of Valencia, all and each one of the canals freely and unconditionally, whether they be large or small, with their waters and smaller channels, from which you may take water for ever, by day and by night And so you

Thus the irrigation systems of the Arabs continued in operation, with slight alterations and few improvements, after the Spanish conquest; the old rules and customs were adopted by the Spanish municipalities, and many of them have since been embodied in modern ordinances; and the works of irrigation have simply been kept in working order, and periodically cleaned, according to immemorial usage. The Arabs irrigated every place to which water could be conveyed either by subterranean tunnels or ordinary canals, and most of these localities continue to present bright patches of green amidst the bare and rocky hills I propose, in the following Report, only to describe in detail those which are most important and interesting, and which I consider as representative,

will be able to take the water and irrigate, without the imposition of any service, tax, or tribute, and you shall take these waters according to the rules and customs established of old, in the time of the Saracens." The *Fueros* of Valencia were in the Limosin language, but have been translated into Spanish and published

Alonzo the Wise, of Castile, granted a like privilege to the people of Murcia on the 23rd of January, 1315, as follows:—"Know all men who may see this letter that I, Don Alonzo, by the grace of God, King of Castile, of Toledo, of Leon, of Galicia, of Seville, of Cordova, of Murcia, of Jaen, and of Algarve, to do good and show favour to the people of Murcia, and to give them satisfaction, hold it good, and command that the waters shall be held by them in common, so that each one shall have his share according to the extent of his land on the day that his turn comes round. Given in Vittoria this 23rd day of January of the year 1315 I, Gil Perez, caused this to be written, by command of the king."

namely:—the *huerta* or garden of Murcia, that of Orihuela, Crevillente, the gardens of Elche and Alicante, Novelda, Jativa and Gandia, the irrigated fields on the banks of the Xucar, the *huerta* of Valencia, that of Castellon, and the well irrigation of Benicarló and Viñaroz near the right bank of the Ebro.

The differences in the customs of each centre of irrigation seem to indicate that the irrigation rules were not enacted by any of the Moorish Governments, but that they were adopted by mutual consent amongst the inhabitants; while their long continuance is a proof of their excellence, and of the experienced benefits which have resulted from them.

III.

THE GARDEN OF MURCIA

THE *huerta* or garden* of Murcia† is a fertile and highly cultivated plain, about fifteen miles long by three or four wide, through which the river Segura flows from west to east. It is bounded, both on the north and south, by bare and rocky slate mountains. It would appear that, at a very remote period, these mountains were covered with forests of pines and other trees,‡ which have been entirely extirpated, and now the naked rocks make a hard and well defined line against the burnished sky. No doubt this change raised the temperature, reduced the rainfall, and rendered irrigation more urgently necessary. The plain of Murcia is certainly a most beautiful spot, with its

* Murcia was called by the Arabs *Al-Bostan* or the garden *Al-Makkari*.

† *Murcia* is said to be derived from *Μυρτος* (myrtle); but this is a mere fanciful idea from the resemblance in the sound. Al Makkari says it was called *Misr* (Egypt) from its similarity to that country.

‡ On the authority of the forest book of Alfonzo XI (A.D. 1312-50), quoted by Rafael de Mancha, p. 6.

old city surrounded by miles of green fields and fruit gardens, and hemmed in by a girdle of rocks "I do not believe," exclaims an enthusiastic Murcian historian, "that among all the fertile and delicious *vegas* of Spain, there is one that can bear comparison with the garden of Murcia, for there are no words capable of describing its delights, nor any land in Europe which offers a view so lovely."

Murcia was, with the exception of Galicia and the Asturias, the only part of Spain which offered any prolonged resistance to the Arab invasion. A Gothic chief of the blood royal, named Theodomir or Tadmir, made so determined a stand in Murcia and Orihuela, after the fatal battle in which Don Rodrigo was killed, that he obtained honourable terms, and continued to reign peacefully until his death, in A.D. 743. Hence the Arabs always called Murcia the land of Tadmir. Ten years afterwards, Abd-er-rahman I. founded the Western Caliphate, and the existing system of irrigating channels in the garden of Murcia, was constructed during the reign of his descendant Alhakem II (A.D. 961-976).* Great numbers of Arabs and Moors of the best families settled in the fertile and delicious plain, and their memory has been preserved to this day in the names of villages, or irrigating channels.† They enjoyed the blessings of peace during the greater part of the two centuries and a half in which the Ommiad Caliphs ruled at Cordova. But on their fall,

* *Conde, Dominacion de los Arabes en España*, p. 244.

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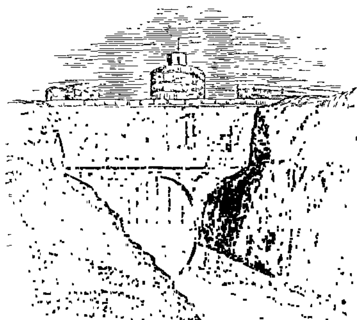
Murcia, like the rest of Spain, suffered from the incessant civil wars. There was a turbulent dynasty of Arab kings of Murcia from A D. 1043 to 1238, and finally the old kingdom was conquered by James of Aragon in the end of 1248, and transferred, according to a previous agreement, to the king of Castile. In 1315 the king Alfonso X granted the free use of the irrigation works of Murcia to the inhabitants.

The river Segura* rises in the mountains which separate Murcia from La Mancha. These mountains are not covered with perpetual snow, but snow may be seen on their summits for nearly two-thirds of the year. Their sides are clothed with pasture, alternating with woods of evergreen oak, pine, poplar, walnut, ash, and juniper in the hollows and ravines; where numerous springs rise and unite to form the Guadalquivir on one side, and the Segura on the other. The whole length of the course of the Segura, including its windings, which are very tortuous, from its source to the Mediterranean, is about 127 miles. Water is taken from the Segura for purposes of irrigation almost from its source, and there are as many as fourteen dams across its course, with their attendant irrigating channels, before it enters the garden of Murcia. It would be superfluous to describe all these in detail, so I proceed at once to the irrigation works of the garden itself.

The great dam, or *anicut* as it would be called in Southern India, which is thrown across the Segura to

* The Romans called this river the Thadar, the Arabs knew it as the Shékurah.

supply the garden of Murcia with water, is four miles to the westward of the city It is called the *presa* or *azud* * The point selected for the dam is where two hills narrow the valley, and oblige the river to force its way between cliffs of alluvial deposit. The dam is 36 feet high, 185 feet wide at the base, narrowing to 15 feet at the crest, and 760 feet long. The southern portion, over which the water of the river falls when it is not in fresh, is entirely faced with cut masonry in steps The rest is composed of large unhewn stones imbedded in lime and earth, and is of great antiquity.



THE SCOURING SLUICE

Close to the left or northern bank there is an arrangement for a scouring sluice, by which the canals can be

* The Arabic form is *as-Sadd* (the obstruction, or dam)

emptied and cleaned, and the deposits of silt swept down. This is done once a year, in the month of March The *escurridor*, as it is called, consists of a masonry wall built across a channel excavated in the rock, on an arch closed up with beams, against which the great deposit of silt rests. Above the arch there is an iron flood gate or *tablacho*, working vertically in a masonry groove, by means of a screw. This can be raised, at any time, without trouble, whenever the irrigation canals are receiving too much water. To empty the canals, it is necessary to throw open the archway below. The beams are first removed, and the water is then only held back by the accumulated silt deposits, which are pierced and stirred, until at last the whole mass is swept away, and the level of the river above the anicut sinks below the bed of the canals, which are then cleared out. This is a very clumsy contrivance, when compared with the under scouring sluices of the Indian anicuts, with their masonry piers, and machinery for opening and shutting. But it must be remembered that the irrigation works of Spain are entirely managed by the tillers of the soil, without any D. P. W. agency, that the use of these contrivances, first invented by the Arabs, has been handed down from time immemorial, and that the people understand them thoroughly.

The unit of measurement for the distribution of water is called a *fila* or *hila*; and the Spanish system has always been one of measurement by volume, and distribution by horary rotation. The system in use in the irrigation canals which have been constructed by

the English in India, is generally one of charging by acreage irrigated, and its disadvantages are obvious. The extent of land under cultivation varies annually, and hence the necessity for annual measurements, and consequent harassing interference with the cultivators.* In native irrigation works in India, especially in the Madras Presidency, the system is one of charging by volume; and the Spanish Arabs have always used a similar method of charging for and distributing water. The *hila*, in the garden of Murcia, is the volume of water that will flow through an opening half a *palmo* (4 inches or thereabouts), in height by a *palmo* (8 inches or thereabouts) wide, in one minute; or a volume of water measuring 50 yards long by a vertical section of 17.1 square inches, equal to about 32 English cubic feet.† The land measure of Murcia is reckoned by *tahullas* of 1600 square yards, equal to .27 of an acre.

The volume of the river Segura was measured in 1816 by Spanish engineers during the month of

* On the Ganges and Jumna canals there is a scale of water rates for different crops: R^s. 5 per acre for sugar cane; R^s. 3 for rice, tobacco, and vegetables; R^s. $2\frac{1}{4}$ for spring crops; and R^s. $1\frac{3}{4}$ for rainy season crops. There is a reduction of one third when the water has to be raised artificially. The Madras Irrigation Company charge R^s. 6 per acre.

† In Italy the old measure, called *macina*, was the quantity of water necessary to drive the wheel of a corn mill, usually considered to be equal to the quantity issuing from an aperture 19·65 inches square, or twelve cubic feet per second

The *modulo* of the Italian civil code is that quantity of water which, under simple pressure, and with a free fall, issues from a rectangular quadrilateral opening with a breadth of 7·874 inches, and a height of 7·874 inches *Baird Smith.*

October, when the water is at its average height. A short distance above the Murcian anicut it was found to be discharging 1,530 *hilas*, or about 48,960 cubic feet per minute. The same engineers found that it required 5 *hilas* of water to irrigate 3 *tahullas* of land. As the irrigated land of Murcia and Orihuela covers 59,066 acres, it is evident that this supply is quite inadequate, and that the most careful and systematic economy, the second use of surplus water by means of the *azarbes* or drains which will be mentioned presently, and a provident eking out of the supply by catching all the rills from the flanking mountains, alone enable the people to extend the irrigated cultivation of these gardens over its present area.

On the left bank of the river two main canals, mother *azequias** as they are called, irrigate the northern side of the river One, called *Churra la nueva*, is taken off by a mouth 13 feet wide, at a distance of 200 yards above the anicut, and irrigates 316 acres in five villages. The other is the principal canal on the northern side, and is called *Azequia Aljufia*,† or the canal of the north. Its mouth is only a few yards above the anicut, and is 10 feet broad, a width which is continued for half a mile, and afterwards it narrows to 8 feet, until it reaches the city of Murcia It is provided with six *escurridores* or scouring sluices, placed at intervals along its course, with openings about 8 to 9 feet high and 2 wide, fitted

* *As-Sakiyah*, a canal through which water runs for irrigation

† *Al-Júf* is not north It means the *centre*.

with flood-gates, and with channels below them, leading to the river. By this means the canal is periodically scoured and cleansed.

The water is distributed from the main canal, into 18 smaller channels on either side at varying distances; and for the purpose of raising water to irrigate land at a higher elevation than the main canal, there are two enormous wheels, one in front of the first *escurridor*, and the other at the village of La Ñora, which together irrigate 105 acres * The wheel at La Ñora is an enormous timber structure, 25 feet in diameter, turned by the water of the main canal. It works on a huge beam resting between two brick walls 24 feet high,



WHEEL AT LA ÑORA.

* The smaller one 23, and that near La Ñora 82 acres.

supported by buttresses, and overgrown with maiden hair and other ferns The periphery of the wheel is fitted with wooden boxes, 28 in number, on each side, each 2½ feet long and 9 inches wide and deep. These boxes are filled through a square hole at one end, as the wheel descends, come up full, and empty themselves as they turn, into an aqueduct on the top of a massive brick wall at right angles with the wheel. They thus raise 40 cubic feet every revolution. The wheel, or *noria* as it is called, is the rendezvous of the village, where crowds of girls come to fill their pitchers; while the groaning and creaking of the massive axle, as the wheel revolves, prevents their gossip from being overheard.*

The distribution of the water for irrigation is effected by *boqueras* or openings in the sides of the channels. Each *boquera* is fitted with a masonry frame, called a *partidor*, in which a flood gate or *tablacho* works vertically in grooves. It is kept under lock and key, and is opened at fixed periods, and for a specified time, when the *tanda* or turn comes round of the cultivators in the *heredamiento* or piece of land which is irrigated by the *brazal* or smaller channel to which the *boquera* leads. The cultivators pay according to the number of *hilas* which flow on to their land, generally three hours in the twenty-four.

One of the most important parts of the Murcian

* "The music of the water wheels on the banks of the Segura, the charming melody of the singing birds, the sweet perfumes exhaled by the flowers, are indeed beauties which baffle all description" *Al Makkari.*

irrigation system, is that which provides for the drainage of surplus water. The sub-soil is a stiff tenacious clay, and arrangements for preventing the accumulation of stagnant water and the formation of swampy ground, are particularly urgent. The irrigating channels, flowing from the right bank of the *Azequia Aljufia*, terminate at the river, but those from the left bank are led down the valley, and have no natural outlet for their surplus water. Very deep trenches, called *azarbes*,* are, therefore, dug in the lower part of the garden of Murcia, which receive, not only the unused water of the channels, but also the drainage of the irrigated land. These *azarbes*, commencing as drains, gradually approach the surface, with the natural slope of the valley, until, on entering the garden of Orihuela, which adjoins that of Murcia, they become channels of irrigation.

The main or mother canal on the south side of the river Segura is called the *Azequia Alquibla*† (canal of the south). It flows off a few yards above the anicut, by a mouth 6 feet wide, and is provided with five *escurridores* or scouring sluices. The first is close to the lower side of the anicut, and consists of a masonry wall, with a *tablacho* or flood gate working vertically in grooves. There are twenty-two irrigating channels taken off from the mother canal of *Alquibla*, and the drainage is effected by a deep trench at the lower end of the valley, called the *Azarbe de Beniel*. The irrigation of the terraced fields and other high land above

* *Az-Zubah*, a drain.

† *Al-Kiblah*, the south. Literally "that which is before."

the level of the canal, is effected by *norias* or Persian wheels, worked by mules. These *norias* are of extreme antiquity, having been used, in one form or another, from time immemorial, by Eastern nations A deep channel is cut from the canal, over which a huge timber wheel is placed, upwards of 15 feet in diameter. By its side are two stone pillars supporting a cross beam, to the centre of which an upright beam is attached. This upright beam is the axle of a double wheel working horizontally, the two parts being joined by strong battens which lock with cogs in the great wheel. A long pole is fastened to the upper end of the upright beam, to which mules are harnessed, and driven round. They move round the horizontal wheel, the battens of which lock with the cogs in the great wheel and turn it round. The great wheel is fitted with a succession of boxes round the circumference, which fill when at the lower end of their revolution, bring the water up, and pour it into a trough leading into a channel. Thus the fields up to 15 feet above the level of the mother canal are irrigated. The upper channel brings the surplus water to another large wheel, which raises it in the same way to terraced fields at an elevation of 30 feet above the *Alquibla* canal.*

* The *norias* in Algiers and elsewhere are usually fitted with earthenware jars, instead of boxes round their circumference. See a full account of several kinds of *norias* used for raising water for irrigation, in the work of M. Morin, "*Des machines et appareils destinés à l'élévation des eaux, par Arthur Morin.*" Paris, 1863, p 89.

The irrigating channels from the *Azequia Aljufia* water 12,757, and those from the *Azequia Alquibla* 12,521 acres, making a total of 25,278 irrigated acres throughout the garden of Murcia. These channels also turn the wheels of thirty-four flour and pepper mills

At a short distance below the city of Murcia, the river of Lorca* or Sangonera flows into the Segura on its right bank, and the numerous destructive freshes in former times, have necessitated the construction of works to confine the waters of the Lorca within bounds.

The proprietary right over the land in Murcia is divided amongst various residents in the city, some of them being titled nobles, and several being descended

* In the last century a dam was erected across this river, near the city of Lorca, forming a very large artificial lake or *pantano*, by means of which an extensive tract of country was irrigated. It appears that the proprietary right in the dam, as well as in the irrigated fields, was vested in a rich landowner named Robles, a relation of that great minister the Count of Florida Blanca, who was also a native of Lorca. Robles had raised the crest of the dam, in order to extend the irrigated area, but the work had been done badly, and it was frequently represented to him that the dam was not strong enough. Robles obstinately refused to believe this, though he at last consented to visit the spot; and he set out in an old family coach drawn by six mules As he approached the dam, a noise like thunder was heard; the postilion declared that the dam had given way, but his master refused to believe it; so the lad wisely cut the traces, and trotted up the side of the hill with his mules. Down swept the irresistible flood, carrying away the lumbering old coach and its obstinate occupant, and about a hundred people besides. The dam has never been rebuilt, for the inhabitants dread a repetition of the catastrophe, although engineers have reported favourably on the project

from the knights who accompanied James the Conqueror or Alfonso the Wise. Chief among them is the family of Faxardo, Marquises of Los Veles, and formerly the hereditary Adelantados of Murcia The land is rented to vast numbers of small tenants or *arrendadores*, whose farms sometimes measure 50 or even 100 acres, but generally do not exceed from 2 to 10. Their rent varies from 28 to 36 shillings per annum, and nominally they are yearly tenants, but practically their holdings are their own, so long as the rent is paid. They are handed down from father to son, and are even divided as marriage portions amongst children, without the previous consent of the landlords. All matters relating to the system of irrigation are under the control of the *Ayuntamiento* or Municipality of the city of Murcia; but the ancient rules and customs have not been embodied in a regular code of ordinances, as is the case in most of the other irrigated valleys of Eastern Spain. In 1350, King Peter the Cruel ordered the land owners of Murcia to elect two judges to settle all disputes relating to the distribution of water, and to superintend all repairs of irrigation works. They were called *Jueces Sobreacequieros*, and were elected annually, the same persons not being eligible twice running. Under them there are *guardias* and other officials to regulate the distribution of the water. Each *tahulla* receives three hours of day and night irrigation, the turn coming round every fifteen days.

The principal irrigated crops are Indian corn, red pepper, alfalfa, (lucerne), all kinds of vegetables, melons,

and gourds, pulses, and some wheat; but it is a mistake to grow wheat in irrigated land, when there are such abundant supplies raised in the adjoining province of La Mancha. There are also large gardens of oranges, pomegranates, vines, date palms, almonds, and figs; and rows of sun-flowers are grown for their seeds, which the people eat. The Indian corn crops are sown in March and reaped in September. A creeping bean, called *habichuela*, is sown with the corn, and after the latter is cut, the little *habichuela*, with its heart-shaped leaf and bright yellow flowers, creeps up the maize stalks, and ripens its pods.* The Indian corn is sold at 24 to 30 reals the arroba, and made into *gachamigas* or fritters with oil and red pepper. But the principal crop of Murcia is the round capsicum or red pepper,† which is sown in rows, in the fields, in June, and picked in October. After picking, the crops are spread out on the rocky hills to dry in the sun, the owners subscribing to pay a guard to watch them. If it rains while the pepper is out, the crops are lost, but there is very little chance of a shower at that season, in the rainless province of Murcia. The mountains which surround the valley present a most extraordinary appearance while the pepper is drying, many of them being one mass of bright crimson. When the pepper is perfectly dry, it

* There are several kinds of *habichuelas* or small beans. The Arab agricultural author, Abu-el-Jair, enumerates eleven different species, according to size and colour of the flowers. The most common is called *Judia* (*Phaseolus vulgaris*)

† *Capsicum grossum*.

sider Murcia to be the most interesting of the irrigated gardens of Western Spain.

In concluding this brief sketch of the irrigation of Murcia, I must take the opportunity of expressing my grateful thanks to Don Juan Albacete y Long, the learned professor of belles lettres in that city, for much valuable assistance.

IV.

THE GARDEN OF ORIHUELA.

THE irrigated *huerta* or garden of Orihuela is the continuation of that of Murcia, and follows the course of the Segura from the Murcian frontier to the shores of the Mediterranean, a distance of about fifteen miles. It is bounded, like Murcia, on the north and south by bare and rugged hills, in some places running up into lofty peaks, in others forming steep precipices The irrigated valley of Orihuela covers an area of about 33,688 cultivated acres, and, besides the city of Orihuela, it contains twenty-four villages with a population of 60,000 souls.

The works of irrigation in Orihuela, like those in Murcia, date from the reigns of the Western Caliphs Abd-er-rahman III and Alhakem II. After the conquest of this part of Spain by the Christians, Orihuela at first shared the fate of Murcia and formed part of the *kingdom of Castile, but it was subsequently ceded to* Aragon. While it was still under Castilian sway, King Alfonso X distributed the land, and gave orders that the tenants should clean the canals and *azarbes*

and repair the works, according to the customs established in the time of the Moors He also ordained that the water should be distributed in the manner prescribed in the Moorish rules. This ordinance is dated September 4th, 1272. King Peter II of Aragon confirmed the arrangements made by the King of Castile, in a decree dated September 24th, 1364. All the rules and customs of Orihuela irrigation were compiled by Don Geronimo Mingot, under orders from Philip IV, and received the royal sanction in a decree dated February 24th, 1645. The ordinances of Mingot are those which now regulate the irrigation of the Orihuela garden, with the exception of the land in Almoradi, irrigated from the *anicut* of Alfeytamy, which has a special set of ordinances, sanctioned in 1794.

The soil of Orihuela is exceedingly fertile, and its system of irrigation is as perfect as that of Murcia. The *hila* or unit of measurement is the same as that of Murcia, namely a volume of water flowing through an opening 4 inches in height by 8 inches in width in one minute; or a volume of water 50 yards long by a vertical section of half a square *palmo*, equal to 32 English cubic feet.

At the western end of the garden of Orihuela the land is irrigated by the *azarbes* or drains which carry off the surplus water from Murcia. The natural slope of the land brings these drains to the surface as irrigating channels, by the time they have reached the boundary between Murcia and Orihuela. On the south side the Murcian *azarbe de Beniel* becomes the

Orihuelan irrigating aqueduct of *Gironda*, and waters 189 acres of land On the north the *azarbe de Zaraiche* becomes the canal of *Santomera*, and, with the *azarbe mayor*, irrigates 1440 acres These canals distribute the water through nineteen *brazales* or smaller channels, and the turn for irrigation comes round every fifteen days.

The irrigation from the surplus waters of Murcia comes to an end a little to the westward of the city of Orihuela, and from thence to the Mediterranean the Orihuelan garden is irrigated by means of eight *azuds* or anicuts thrown across the river Segura. The first is called the *azud de Beniel*, and is three miles west of Orihuela It was formerly flanked by towers, whence notice of the approach of enemies was given to the inhabitants of the *huerta*. This *azud* was rebuilt in 1829, and now gives irrigation to 5369 acres of land. Close to the *azud* there are two large *norias* or wheels twenty feet in diameter, and fitted with twenty-four double boxes round the circumference, for raising water. Two main canals are taken from each side of the *azud*, and after irrigating 4903 acres, pour their surplus waters into the *azarbe mayor de Hurchillo.*

The next dam, following the course of the river, is called the *azud de los huertos*, which sends off a canal of the same name to irrigate 1773 acres There is a *noria* in this canal, twelve feet in diameter, for raising part of its water to a high level, and twenty-two distributing channels.

The third dam is called the *azud de Almoradi*, opposite the city of Orihuela It sends off four canals

to irrigate 5000 acres. The *azud de Callosa,* near the former, is the fourth. The canal of Callosa irrigates 13,000 acres, and the water is raised, for the irrigation of high land in the northern part of the garden, by seven wheels moved by the flow of water, which are fourteen feet in diameter. The fifth dam, called the *Azud de Alfeytamy,* was originally merely intended as a weir for a flour mill, but between 1571 and 1615 channels were excavated on both sides of the river, This *azud* is two leagues east of Orihuela. The *azud de Formentera* is the sixth, and is three leagues east of Orihuela. It sends off a channel on either bank, and, on the south channel, there is a *noria* or wheel twenty feet in diameter, with forty-eight double boxes for raising water. Next comes the *azud de Rojales,* and the eighth and last is the *azud de Guardamar,* fourteen miles east of Orihuela. The irrigating channels of Orihuela turn nineteen mills.

The whole garden of Orihuela rests on a compact bed of clay, so that there can be no natural filtration. Hence the necessity, as in Murcia, of excavating deep *azarbes* or drains to receive the surplus water from the land and the numerous channels, and conduct it to the river again, to be used for irrigation at the next dam. During the time of the Moors, and even down to the last century, there were large tracts of swampy unreclaimed land at the lower end of the garden of Orihuela, near the shores of the Mediterranean. In 1721 they were granted to Cardinal Ballegas, the Bishop of Cartagena, who caused very deep drains to be dug, which collected the stagnant water and drained

it off into the river Segura on one side, and into the *albufera* (salt lake) of Elche on the other. A very extensive tract of country was thus brought under cultivation, and supplied with irrigation from the system of Orihuela; and the three villages of Dolores, San Felipe, and San Fulgencio owe their existence to this public-spirited act of the good Cardinal.

The irrigation system of Orihuela is under the management of five *Jueces Sobre-azequieros* or Judges of the water courses,* who administer the ancient rules which are embodied in the Ordinances of 1645, and divided into thirty-seven Sections. They provide for the punctual payment of all irrigation rates by the cultivators, no defaulter being allowed to receive water, and the Judges being empowered to put in executions for the amount, and to inflict imprisonment. All openings for the distribution of water are ordered to be of masonry, and fitted with grooves for the gates; and fines are to be inflicted on any cultivator who makes any unauthorised breach or opening in a channel. The openings are to be a foot higher than

* 1 The judge of Orihuela regulates all the water which comes from Murcia, and that derived from the first four dams across the Segura, in the garden of Orihuela.

2. The judge of Callosa superintends the irrigation from the *azud* of the same name

3. The judge of Alfeytamy performs the same office for the water derived from the *azud* of that name, and lives at Almoradi.

4 The judge of Formentera regulates the water from the sixth *azud*.

5. The judge of Guardamar superintends irrigation from the seventh and eighth dams.

the floor of the mother canal, and they are to be kept closed at all times when it is not the turn of the cultivators to whose land the water flowing through them would come The turns by horary rotation, established in each division, are to be inviolably observed on pain of fines. These turns vary from seven to thirty-one days, according to the canals, those from the Azud de Beniel being diurnal, but the average is fifteen days There is a *Repartidor* for each channel, elected by the cultivators, whose duty it is to see that the *tandas* or turns are duly observed; and if there is a dispute between a *Repartidor* and any of the cultivators, it is referred to the Judge of the Division for adjudication, who may impose a fine on the party he considers to be in the wrong. The planting of trees on the banks of *water-courses is strictly prohibited, and all flocks and* herds are absolutely forbidden from approaching any *azequias* or *azarbes*, on pain of a heavy fine.

It has already been said that the lands of Almoradi, irrigated from the *azud* of Alfeytamy, have a separate set of Ordinances, divided into thirty-six Sections, which were approved by the Government in 1794. They are rather more democratic than those which govern the irrigation of the rest of the Orihuelan garden. The *Sobreccquiero*, or Judge of the Water-courses, is elected, every three years, on the 15th of December, by the whole body of tenants. His jurisdiction commences on the following new year's day, and he must be a person of pure life, a resident in the village of Almoradi, engaged in cultivating irrigated land, and he *must have a certain property* qualifica-

tion. The tenants also elect a lieutenant to perform the duties of the judge in the event of sickness or absence; and a *Sindico* and four *Electos* to form a *Junta*, or Board, entrusted with the receipt and disbursement of funds. The duties of the Syndic are to see that all the channels are cleared in March; and, with the assistance of *Peritos*, or experienced appraisers, to calculate the estimated expenses for the year, including salaries of irrigation officials, and to divide this sum among the tenants according to the number of *tahullas* occupied by each. Payments are to be made within fifteen days, and defaulters are liable to seizure of goods or crops. The Syndic also keeps lists, by which he gives notice to the cultivators respecting their *tandas*, or turns for irrigation, and any one irrigating out of his turn, has to pay all losses to him whose turn it was, besides a heavy fine Damages are assessed by *Peritos* nominated by the Judge.

V.

IRRIGATION ROUND CREVILLENTE

AMONGST the inhospitable and arid mountains which surround the little town of Crevillente, nine miles north of Orihuela, there is neither river, nor any surface water wherewith to form a tank: and here it might naturally be supposed that the perseverance and ingenuity, even of such agriculturists as the Spanish Arabs, would be baffled. But it is not so. About four hundred Arab families settled at and around Crevillente in Moorish times;* and succeeded in forcing the naked rocks to yield sufficient for their sustenance, by adopting a method of obtaining water which must have been learnt from those ancestors who, from time immemorial, had practised a similar method amidst the arid rocks of Arabia.† The early settlers at Cre-

* Nearly all the Moorish inhabitants emigrated at the time of the Spanish conquest, but many of their daughters were seized as wives of the new settlers. In the time of Cavanilles there were 1800 families in Crevillente. Ford mentions that Crevillente was long the hilly lair of the bandit Jaime el Barbudo.

† Wellsted describes this method of irrigation, as it is prac-

villente sought for underground fountains in the surrounding mountains, and with the help of that instinct acquired by long experience, and after many failures

used in the Bediah, and other oases of Omán He says.—"The oasis of Bediah, and nearly all those in the interior of Omán, owe their fertility to the happy manner in which the inhabitants have availed themselves of a mode of conducting water to them, a mode, as far as I know, peculiar to this country. The greater part of the face of the country being destitute of running streams on the surface, the Arabs have sought in elevated places for springs or fountains beneath it. By what mode they discover these I know not, but it seems confined to a peculiar class of men who go about the country for the purpose, but I saw several which had been sunk to a depth of forty feet. A channel from this fountain head is then, with a slight descent, bored in the direction in which it is to be conveyed, leaving apertures at regular distances, to afford light and air to those who are occasionally sent to keep it clean. In this manner water is frequently conducted from a distance of six to eight miles, and an unlimited supply is thus obtained. These channels are usually about four feet broad and two deep, and contain a clear rapid stream. Few of the large towns or oases but had four or five of these rivulets or *felej*[1] running into them. The isolated spots to which water is thus conveyed possess a soil so fertile, that nearly every grain, fruit, or vegetable common to India, Arabia, or Persia is produced almost spontaneously." *Wellsted's Travels in Arabia*, i, p. 93.

The same subterranean irrigating channels are used in Affghanistan, where they are called *kahrezas*. See *Journal of the Asiatic Society of Bengal*, vol. ix, p. 37.

See also a very interesting account of the *Fontanili* in Piedmont, in *Baird Smith's Italian Irrigation*, i, pp. 33-45-61.

Falaj[1] means an interstice, hence a brook or rivulet. Locally, in Omán, it may have the signification of an irrigation canal.

and disappointments, they succeeded in ascertaining the depth and position of two or three. A subterranean passage was then excavated, with the usual slope of an irrigation canal, in the direction of the supposed water, and the means of fertilising the rocky desert were obtained. For the Arabs had invented a leveling instrument from very early times, and the correct direction was preserved by making vertical apertures at intervals, whence the bearing of the supposed position of the spring was observed The principal subterranean excavation of Crevillente crosses the ravine near the town on a large arch, and then passes for 855 yards through hard rock At this point it forks into two passages going in the direction of two different springs, and the whole length of the longest of these underground channels is nearly a thousand yards. In some places the height of the tunnel is twelve feet, excavated out of the solid rock.* But the inhospitality of the Crevillente hills is such that water is not the only want It is necessary also to bring soil from a distance before any fruit or grain can be produced. Down the sides of the ravine, on the edge of which the town of Crevillente stands, terrace walls have been built, and the intervening spaces have been filled with soil. These terraces are irrigated by watercourses

* *Observaciones sobre la historia natural del Reyno de Valencia por Antonio Cavanilles* (Madrid, 1795), vol ii. Cavanilles crawled up one of these tunnels at Crevillente, nearly as far as the source of the water supply; and complained of the enormous quantity of bats which flew about in the dark. I had no time to make a similar expedition.

from the subterranean canal, and the white flat-roofed houses now rise above a fine growth of date palms, vines, figs, and pomegranates. But the industry of the frugal inhabitants of this wild and rocky desert is displayed in a remarkable degree, in every direction. In places where artificial irrigation extends, fields and terraces are watered by a careful system of *tandas or* turns, but cultivation is not entirely confined to the area within the influence of the laborious irrigation Terraces are built up the sides of rocky mountains and planted with vines, and even in corners and crannies, where only single trees can find space, walls are built across the sharp angles of ravines, the little triangular step thus formed is filled with soil, and one fig or algarrobo or olive tree finds standing room. Of these trees the most characteristic are the carob or algarrobo (*Ceratonia siliqua*), which were introduced from Syria by the first Arab invaders. The young tree is transplanted from the nursery when about four years old, and is placed in a deep hole filled in with soil mixed with straw. It is watered once or twice during the first year, and sometimes protected by a fencing of reeds, but it soon becomes strong and vigorous, with a large trunk and smooth white bark, and yields a harvest of pods affording excellent fodder for mules and horses. There is an account of the cultivation of the algarrobo in the work of the Arab agriculturalist, Ebn el Awran (I, cap. vii, p 246).

The system of irrigation by means of underground channels, common alike to the Arabs of Omán and to those of Spain, was brought to a far higher degree of

perfection by the admirable government of the Yncas in Peru; and in no place in the world may it be seen in such excellent working order as in the Peruvian coast valley of Nasca, where all the works date from an Yncarial period.* I never met with any irrigation

* Cieza de Leon, writing between 1532 and 1550 A.D., says—"The Indians of Peru had, and still have, great works for drawing off the water, and making it flow through certain channels Sometimes it has chanced that I have stopped near one of these channels, and before we had finished pitching the tent, the channel was dry, the water having been drawn off in another direction, for it is in the power of the Indians to do this at their pleasure"

Next to the wonderful roads, these irrigating channels are the most convincing proofs of the advanced civilisation of the Yncas. Once nearly all the Peruvian coast valleys were supplied with them; but now the irrigating channels of the Yncas are in working order only in the valley of Nasca. Their remains, however, are to be met with everywhere The valley of Nasca descends from the Andes by an easy and gradual slope, widening as it descends, and is covered with vineyards, cotton plantations, fields of capsicum, maize, pumpkins, melons, and fruit gardens. Yet all that nature has furnished in the way of water supply is a watercourse, frequently dry for years together, and at the best only a little streamlet trickles down during the month of February. The engineering skill displayed by the Yncas in remedying this defect is astonishing. Trenches were cut along the whole length of the valley, becoming tunnels at the upper end, and penetrating into the rocks until they come in contact with underground springs. They are some four feet in height, with the floor, sides, and roof lined with stones, and are called *huirca*. Lower down they separate into branches, which ramify in every direction over the valley, and become *rarca* or surface channels, supplying all the estates with delicious water throughout the year, and feeding the little watercourses which irrigate the

of this description during my journeys in the peninsula of India; but there are vast tracts of rocky uninhabited desert, especially in the Ceded Districts, where similar works might doubtless be advantageously constructed, whenever the increase of population makes it necessary. Near Cape Comorin, too, where the ghauts are broken up into isolated clusters of weather-worn hills, with sharp peaks and rugged precipices, many streams flow down their eastern sides during the rains. These streams are heavily charged with silt, and after flowing for about a mile, are apparently choked by their own deposits, which spread out over half an acre of ground. If their drainage was received into tunnels such as those near Crevillente in Spain, in the oases of Omán, and at Nasca in Peru, most welcome additional supplies would be secured for the thirsty land which, in this part of Tinnevelly, is dependent for water on the precarious rainfall furnished from tanks.

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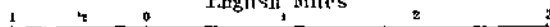
fields At intervals of two hundred yards there are man holes in the main tunnels. See my translation of *Cieza de Leon*, p. 236 and note; and *Cuzco and Lima*, p. 46.

VI.

TANK IRRIGATION OF ELCHE AND ALICANTE.

MURCIA, Orihuela, and some other irrigated valleys which will be described further on, are instances of irrigation effected by throwing anicuts across rivers. Elche and Alicante, on the other hand, are excellent representatives of the tank irrigation of Spain. In most of their details these Spanish tank systems resemble those of the Madras Presidency; and though the former are on a diminutive scale in comparison, yet both are of great antiquity, both of native origin. It is well known that the whole tank system of Madras, including near 50,000 separate tanks, and, according to Baird Smith, somewhere about 30,000 miles of embankment, is so completely due to native skill, previous to the English dominion, that, down to 1853, not a single new tank had been constructed by us. That the tank irrigation of western Spain is not of Christian but of Arab origin, and therefore at least eight centuries old, I shall be able to adduce most interesting proofs.

TANK IRRIGATIO[N]
OF
ELCHE.



Vallongues
Pantano
Tank
of Elche
Dam
Mill
Tunnel
Mill of Baxos
New Mill
Acequia Madre
Mill of La Torreta
Mill of Two Wheels
Partidor de Arbinella
Partidor de Correy
Partidor de Arnel
Partidor de Forat
Partidor de Arnoy
Partidor de Candalix
Partidor del Real
Mill of the Palm Grove
Mill of Real
ELCHE
Bridge
Partidor de Albet
Partidor de Matrof
Partidor de Nais
Partidor de Tuta
Partidor de Cunera
Partidor de Somnce
Partidor de Alfranca
Partidor de Lausa
Partidor de Borocat
Partidor de Noela
Partidor de Palomar
Partidor de Aval
Azequia de Marchena
N
San Antonio
El Derramador
Albufera

Elche* is twenty miles north-east of Orihuela, and seven from the shores of the Mediterranean. It is a city of palms Built on the edge of a torrent bed, which is spanned by a handsome old bridge, the flat-roofed houses of Elche are surrounded on three sides by groves of date palms The grand old Moorish alcazar (now a prison) stands on the edge of the *rambla* or ravine, and the three or four church towers, in place of minarets, alone serve to remind the traveller that he is not on the confines of a town in Arabia or Morocco. The great feature of Elche is its date palms, the introduction of which into Spain is traditionally referred to Abd-er-rahman I., who daily contemplated the first Spanish palm from his palace window at Cordova, or watered with his tears the tree which was once irrigated by his beloved Euphrates. He felt half mortified that the palm should raise its crest towards heaven and expand with the kisses from the breezes of Algarve, while he, another exile from the East, pined for the sweeter air of his native land.† And truly the descendants of the famous palm of Abd-er-rahman, with their fifty feet of stem, crowned by the golden bunches of fruit and graceful leaves, feel quite as much at home in the gardens of Elche as they ever did on the banks of the Euphrates.

The fertility of Elche is due to the great tank or artificial lake which was formed by the Arabs, several

* From *Lugja*, or with the article *Al-lujja*, a broad and fertile plain.

† "Con mis lagrimas regué las palmas que el Forat riega." *Conde, Dominacion de los Arabes*, p. 85.

reaches Elche quite independently of the irrigation channels, where it is of course a great boon to the people.

The main irrigating canal or *Azequia Madre*, on first issuing from the dam, flows along the dry bed of the *Vinalapo* ravine for a short distance, until the ravine takes a sharp turn to the south. The canal is then divided into two branches, one flowing down the ravine, and the other being led through a tunnel excavated in the side of the mountain. At a distance of about half a mile the two streams unite, in an excavated channel which flows direct to Elche, being taken across ravines on aqueducts, and in some places being conducted through rocky spurs from the hills, by means of tunnels or deep cuttings. By the arrangement of dividing the stream at its commencement, the means are provided of cleaning out the tunnels, by allowing the whole volume to flow into the lower branch. The deep ravine of the *Vinalapo*, being the dry bed of the torrent which existed before the tank was constructed, cuts deep into the alluvial soil, having scarped cliffs on either side, and, passing the town of Elche which overhangs it, extends to the shores of the Mediterranean. The *Azequia Madre* flows down, close to the cliffs on the left side of the ravine; and, at a distance of three-quarters of a mile from the dam, another channel branches from the main canal, crosses the ravine, and is led down the right side as the *Azequia Marchena*, to supply water for the small extent of land which is irrigated on the southern side of the ravine.

At a distance of a mile and a half above Elche the *Azequia Madre* begins to send off *partidores*, or secondary irrigating channels, of which there are twenty-two in all, seven above the town, and fifteen below it, all of course issuing from the left bank of the mother canal, as the edge of the ravine is close at hand to the right The names of these *partidores* give more distinct proofs of the Arabian origin of the irrigation system of Elche than could be obtained either from traditions or even from written chronicles. I obtained these names from the mouths of millers and cultivators who live on the banks of the channels and use their water, and I am indebted for the following explanations of their meaning to that eminent Arabic scholar, the Rev. George P Badger.

Counting from the western end of the irrigated garden, or that nearest to the tank—they are as follows —

1. *Arbinella* This word is possibly composed of two others, *Arbaain illah*, the "forty pure springs". The singular of *illah* is *ill*, which means a person or place whence anything pure originates

2. *Carrey* Probably *Karizy*,* "a channel through which water flows from a mountain"; or the place in which such water is received in a garden or field.

3. *Aznel.* From *an-Nazal*, "descent, flowing". The channel of the descent or slope.

4. *Forat.* *Farat*, "plenty, superfluity".

5. *Annoy.* Perhaps for *Ghanizy*, "rich".

* Or *Kahreza*. See note at page 39.

6. *Candaliz.** There is an Arabic word, one of the rare instances of a noun with five radical letters, which is something like this—namely, *Khandalis*; but, as it means a number of lean camels, it is hardly likely that it can be the name of this channel. Candaliz may be a corruption of *Kanz-al-izz*, "the treasure of dignity or happiness".

7. *El Real.*

These are the channels above the town of Elche. The rest flow off from the mother canal after it has passed the town, and are as follows:—

8. *Albeit.* *Al-beit*, "the house".

9. *Mijasa.* Perhaps *Majassah*, "put together with lime". The same word is used to express fulness, repletion, etc.

10. *Matrof.* *Mutraf*, "Affluent. Bestowing the comforts of life".

11. *Alcana.* Perhaps *Al-ghaná*, "Riches, wealth", also "a valley abounding with trees". Or it may be *al-kanáh*, "the aqueduct, channel".

12. *Nafis* *Nafiz*, "penetrating, going through, effectual".

13. *Tufa.* Perhaps *Tufooh*, "fulness to redundancy".

14. *Cuñera.* Possibly *Kinnára*, "a harp, or guitar", from the musical sound of the water flowing through the channel.

15. *Saunee.* Probably *Saniyy*, "Precious, beautiful". The root of this noun (*Sana*) signifies to irrigate land with a water-wheel.

* In Spanish *Candelizas* are the clew-garnets, or ropes for clewing up the fore and main courses

16. *Aladea.* A feminine form, "passing, running, flowing".

17 *Alfranc.* *Al-Frank,* "the Frank or European." The two channels called Aladea and Alfranc issue from the mother canal as one, and separate afterwards, the latter being of later date.

18. *Lausa* Perhaps *Lazzah,* "delight, enjoyment".

19. *Borocat. Barakat,* "abundance, fertility, blessing".

20 *Natla.* Perhaps *Natlah,* "a draught". The verb *Natal* throws off several forms signifying redundancy. Or it may be *Nathal,* a ditch.

21. *Palomar.*

22. *Aval.* *Awwal,* "first".

The *Aval* is the last of the secondary channels, and is about two miles below the town of Elche.

The mother canal is cleaned out every year, in the month of September.

The *fila* in Elche is a very different measurement frôm the *fila* of Murcia and Orihuela. The whole volume of water brought down from the tank, by the *Azequia Madre,* is divided into twelve equal parts called double *filas* or *hilas* of water, and their measurement must of course vary according to the supply from the tank. Thus there are twenty-four single *hilas* corresponding to the twenty-four hours of the day, twelve for day and twelve for night irrigation. Two of these *hilas* are set apart for the use of the town, one for the land on the right bank of the ravine, irrigated by the *Azequia Marchena,* and the other nine for the garden of Elche on the left bank. Numerous *brazales* or small water-courses, leading from the channels with

Arabic names, conduct the water to the fields, and at every opening there is a wooden flood-gate with a lock and key.

The possession of a single *hila* is in other words the right to use, in the proper turn, the twenty-fourth part of the volume contained in the mother canal for the space of twelve hours. The time from six A.M. to six P.M. being the day *hila*, and from six P.M. to six A.M. the night *hila*, the time being regulated by the town clock. These *hilas* are divided into half *hilas* of six, and quarters of three, hours. The water is sold every morning by the Irrigation Officers at a place called the *Troneta* in the public square of Elche, at eight in winter and seven in summer. The officer announces the *hilas* which are on for that day, and the cultivators whose turns have come round. The cultivators then indicate the particular land which they require to be irrigated; or the person to whom they have sold their claim, if they do not require water on that particular day. The names of the channels whence water will be distributed on that day, and the other details, are then published.

The superintendence and government of the irrigation of Elche is entrusted to a *Junta* or Board presided over by the Alcalde of the town, and consisting of four other members. Two of these are the Sindic or Recorder to represent the municipality, and the Regidor Decano to watch the interests of the public. The other two must be engaged in the cultivation of irrigated land, and are elected annually by the body of cultivators, every person, having a right to half a

hila of water, being entitled to a vote. The general meeting of cultivators assembles to elect the members on the second Sunday in January. The duties of this Board are to superintend all matters relating to irrigation and to the repair of the works, and to manage the funds. The services of its members are given gratuitously.

The other irrigation officers receive salaries, and are nominated by the Board. They are the *Depositario*, the *Contra-libro*, and the *Fiel Repartidor* or faithful distributor. The *Depositario* assists at the sales of water every morning at the *Troneta*, takes notes of the sales, and is responsible for the payment of money by the purchasers. He is bound to submit his accounts to the Board every year, which are audited by two of their number, and the *Depositario* must make good any deficiency within three days. The *Contra-libro* also has to be present at the sales, to take note of the cultivators who irrigate each day, of the fields irrigated, and of the quantity of water taken. All these particulars are entered in a book. He also has to superintend the execution of all repairs in the channels The duty of the *Fiel Repartidor* is to lock and unlock the *tablachos* or doors in the channels, and to see that no water is taken improperly, but he is strictly prohibited from selling any water, which can only be done at the *Troneta*

These rules were framed from the old Moorish customs, and, having been embodied into an Ordinance consisting of nineteen sections, were approved by a Royal Order dated January 9th, 1796

The irrigated area of the garden of Elche covers 8729 acres. The palm trees, often fifty feet high, are planted in rows along the water-courses, and round the small fields. Ebn-el-Awram* treats of their cultivation, and the Moors distinguished the male from the female, centuries before Linnæus taught the sexes of plants. The cultivators of Elche plant one male between two females, and the fructification is effected by the wind, and not artificially, as in India. The young palms are raised in nurseries until they are three years old, when they are planted out in rows six feet apart. They are irrigated once a week. The intermediate fields are sown with alfalfa, maize, vegetables, and pomegranates; and beyond the area of irrigation there are plantations of olives, fig trees, and fields of corn. A number of mills are turned by the mother canal, and the clean comfortable houses of the millers are shaded by palm trees, as well as by vines creeping over the verandahs. In this beautiful climate the corn is spread out to dry upon platforms resembling the barbecus of Indian coffee planters, which are still called by the Arabic name of *alfarige*.†

The garden of Alicante is also irrigated by means of a large tank or artificial lake; but, as I have described the Elche system in detail, it is superfluous to make more than a brief allusion to one which, in all its essential features, is similar.

* I, p. 1, cap. vii, art 43, p. 344.

† *Al-Farsh.* Anything spread on the ground, as a mat or carpet.

The dam for the Alicante tank is about a league south of the village of Tibi, and is built across a gorge between two masses of naked limestone rock, called Mos de Bou and Cresta. According to Cavanilles the height of this dam is 150 feet, its thickness 66, and its length 172 feet. The arrangement for cleaning out the tank, which is half a league in extent, is the same as that in use at Elche. At the west end there is a calingulah for letting off the water when the tank is very full. This dam was commenced in the year 1596, but entirely rebuilt in 1738. The canal flowing from the dam, is provided with a bed excavated out of the solid rock. It irrigates 8074 acres in the garden of Alicante, which is three miles long, from east to west. The river Monnegre, for the constant supply of which the water is stored in the tank or *pantano de Tibi*, flows thence to the sea, through the garden of Alicante. Two *azuds* or anicuts are thrown across this river. That of Muchamiel, furthest from the sea, is a curved wall of masonry, whence a deep irrigating channel is taken along the base of the hills, with a stone wall on one side, and five calingulahs or outlets for surplus water That of San Juan, also a curved masonry wall, is larger and nearer the sea.

The productions of the garden of Alicante are vines, barley, wheat, maize, almonds, olives, hemp, figs, alfalfa, and other fruits and vegetables; besides algarrobos and the *Schinus molle*

VII.

IRRIGATION AT NOVELDA.

The system of irrigation at Novelda is deserving of special notice, on account of the peculiar rules which have been handed down from the time of the Arabs, and still prevail there.

Novelda is one of the first stations on the railroad from Alicante to Madrid, and is a nice little town surrounded by a fertile garden. The irrigated area is about two leagues long from east to west by one league broad. The springs of Jaut, whence the irrigating channel is conducted to the garden, are about six miles distant. A wall, with a curve towards the current, is built across the ravine, nearly two hundred yards long, and the channel is taken through three tunnels hewn out of the rock, and over several ravines on arches. The Novelda garden yields corn, maize, alfalfa, pomegranates, and vegetables, but it is especially famous for its *alficos* or serpent cucumbers (*Cucumis flexuosus*, Lin.), which are twelve times as long as broad. The people are very fond of them.

There is a mark at the upper end of the irrigation

channel up to which the water is private property, but the volume which rises above this level forms what is called a *hilo*, belonging to the public. The volume of water, which is private, is subdivided into four *hilos*, which flow over the whole garden. One of them supplies the town Each of these *hilos* is double, and is again divided into single *hilos* for day and night, counting from six in the morning to six in the evening, and *vice versâ*. The single *hilos* are further subdivided into parts, called *azumbres*, consisting of the use of the water for the space of one hour and a half. The whole number of 336 *azumbres** is the property of several owners, some of whom possess no irrigated land of their own, and their water is of course the subject of many bargains.

The distribution of water is not made with reference to the different holdings of land, but according to the property in *azumbres* of water, the use of which comes round every twenty-seven days. A turn is established, called *martava*, and the hours for each *azumbre* are fixed. Between the periods for the usufruct of the *azumbres* of private individuals, six days are intercalated, during which the water is sold by the authorities, in order to provide the funds for the repair and improvement of the channels, and for other expenses connected with the irrigation works. It is remarkable that the word used for a turn in Novelda is

* *Azumbre* is a Spanish liquid measure equal to 0.4122 of a gallon. In Arabic *As-Sanbûr* is a water-spout or pipe. In Syria the water for irrigation, to which cultivators are entitled, is measured by the size of the pipe through which it flows

not the Spanish *tanda*, but the pure Arabic form *martava.**

The velocity of the flow of water in each *brazal* or irrigating watercourse is calculated; and the time is marked that the water takes in flowing from the outlet of the *partidor* or branch channel to the outlet where it enters the irrigating *brazal*. The town clock serves as a guide, and the water is allowed to flow through the *boquera* of each cultivator during the exact time to which he is entitled.

Every day at noon the sale of water takes place from the *Troneta*, under the portico of the town hall of Novelda. The owners of *azumbres*, whose turns fall upon that day, have to state in what part of the garden they desire that the water, to which they are thus entitled, should be delivered, whether for their own use, or for that of persons to whom they may have sold their right.

The official, to whom is entrusted the difficult and confidential duties of managing the distribution and sale of the water, is nominated by the Municipality. He is called the *Alami*,† a word of Arabic origin; and the post is one requiring so much special knowledge, that it is always given to the members of certain families, who have held it from time immemorial. When the *Alami* has knocked down an *azumbre* to the highest bidder, he asks—"Where?" The bidder re-

* *Martabah*, a degree, a step. The word is also used in Persian and Turkish to signify a time or turn, and in India.

† *Alim*, giving information, certifying. *Aldmi* would be the adjective form—"One who certifies."

plies—"In such a channel, for such a piece of ground". After the sale of the next night's *hilos*, those of the next day are sold, and the *Alami* then arranges the distribution of the water according to the number of hours it is to flow into this or that channel. Each buyer is supplied with a receipt, on which the time during which the water is to flow, and the field to be irrigated, are marked. This receipt is still called by the Arabic word *albará*.* At the time of receiving the *albará*, the buyer is bound to pay the price of the water

It will at once be seen that the duties of the *Alami* require constant attention, much care, and an intimate knowledge of the localities, for their satisfactory performance. He has to remember where the *hilos* of day and night irrigation have been delivered during the previous twenty-four hours, and which is the nearest among those sold on the current day, to combine the directions in which the water should flow with the requisite volume, so that there may be sufficient in the places where each *azumbre* is to be delivered, adding to, or diverting from, the various channels, so as to secure these ends. These complicated operations can only be satisfactorily performed by persons who have had long experience, and are withal quick-witted and intelligent.

The *albará* is the title empowering the cultivator to use the water for a certain time. He knows the time it will take for the water to arrive at his outlet, and opens it at the right moment. When the velocity of

* *Al-Bará'at*, the writing conferring immunity or exemption.

the current is not marked, as is sometimes the case in the intermediate parts of a channel, an operation called *tira brosa* is performed. A faggot is launched into the channel at its head (others which, from their shape, go down faster than the current, being taken out), and the cultivator follows it until it comes opposite to his opening, when he raises the gate, and his turn of irrigation commences.

The antiquity of these customs is very great, and the peculiar terms used at Novelda, point with certainty to their Arabian origin.



Villanueva de Castellon
Rio Sellent
Vª del Rey
Sellent
Llosa de Ranes
Corberá
Llánera
Vª del Conde
Tosalnou
Torrente de Fraollet
Granja
Alcudia de Crespins
Cerda
Vallés
Torre Cerdá
Ancoro
Canals
Santa
Santa
Azud de Ranes
Azud de la Vila
Rio de los Santos

VIII.

THE GARDENS OF JÁTIVA AND GANDIA.

BEAUTIFUL Játiva, the birth-place of the Borgia Popes and of the painter Spagnoletto, is surrounded by an irrigated garden, with its thickets of mulberries, and fringe of algarrobos, olives, and vineyards. The grand old castle, so gallantly defended by the English during the war of succession,* rises above the ancient and most interesting city, whose history has been so lovingly and painfully written by Don Vicente Boix, the accomplished Chronicler of Valencia.

The garden of Játiva is irrigated by water from the three rivers, Albaida, Montesa, and Los Santos, all tributaries of the Xucar, and from several springs. The Spanish Arabs, while establishing that famous paper manufactory at Játiva, whence the art of making paper was extended to the nations of Europe, did not neglect the works of irrigation necessary to fertilize its garden.

* In this castle the Infants of La Cerda were confined (the rightful heirs of the throne of Castile); and afterwards it was the prison of Cæsar Borgia.

Twelve irrigating canals are drawn from the above-mentioned rivers.

1. The canal of *Murta* is taken from the river Albaida, by means of an *azud* constructed of stakes and fascines, which is of course in need of incessant renewal. It absorbs nine out of the thirty-three parts into which the volume of this river is considered to be divided, which are held to measure a *fila* each when the river is at its average height. The *Murta* canal irrigates 1698 *fanegadas*.*

2. The canal of *Puig* is taken from the Albaida by means of a masonry anicut. It is conducted through a rocky hill which overhangs the river, by a tunnel, and draws off eighteen out of the thirty-three *filas*, to irrigate 5600 *fanegadas* of paddy cultivation.

3. The *Benifurt* canal also comes from the Albaida, and is drawn off by means of an *azud* of stakes.

4. That of *La Torre* also has an *azud* of stakes and fascines.

5. The canal of *Santa* is derived from a spring near the river Montesa, and has a volume of three *filas*, which is conducted by subterranean pipes of clay into the city, to supply the fountains and private houses.

6. That of *Losa* is brought from the Montesa river by means of an *azud* of stakes, and irrigates 7500 *fanegadas* with six *filas*.

7. The canal of *Meses* is also brought from the Montesa by means of a masonry anicut, and has a

* One *fanegada* = 1·13 acre

volume of twelve *filas*, sufficient to irrigate 3703 *fanegadas*.

8. That of *Foyes Velles* also comes from the Montesa, by means of an *azud* of stakes and fascines; as does the canal of—

9. *Foyes Noves*

10. The canal of *Vila* is taken from the river Los Santos, by means of a dam of rough stones. The *Vila* canal has a volume of nineteen *filas*, out of the twenty which the river is considered to contain.

11. The canal of *Ranes* takes the other nine *filas* from the river Los Santos

12. The *Bellus* canal is derived from a spring of that name.

All these twelve canals send off thousands of smaller watercourses, which ramify in every direction over the garden of Játiva; and most of them have a separate code of ordinances for their regulation.

The garden of Gandia lies between Játiva and the Mediterranean, and is separated from Játiva by a range of hills. To the south is the hill of Santa Ana, and to the north the hill of Bayrent, near Gandia, crowned with its hoary old castle. From the Mediterranean to the hills of Azafar, which bound the garden of Gandia on the west, all is fertility. Within these limits there are nineteen villages, containing 7,500 inhabitants.

Gandia was the home of that remarkable race of Borgias, to whom it also gave their ducal title. Here lived the great and vile, the good and bad, the saints and sinners of that famous line whose scions filled all

the world with their fame. "The universe was full of them", declares their historian, who adds that there are Borgias in heaven, Borgias in hell, Borgias in the east and west, in court and cloister, on sea and land—Borgias everywhere.

The garden of Gandia is irrigated by water from the rivers Alcoy and Bernisa, which unite and fall into the Mediterranean; and comprises 35,506 *fanegadas* of irrigated land.

All the works of irrigation are due to the Arabs, and the use of the water was confirmed to the inhabitants by the Conqueror Jayme I of Aragon. A division of the land amongst the old Moorish inhabitants and the new settlers was made in 1244 by Don Peregrin de Trujillo, Governor of the old castle of Bayrent, which overhangs the town of Gandia. In 1689 the Duke of Gandia brought a complaint before the Royal Audience of Valencia, against the formation of dams above the garden, and he obtained a Royal Decree of *nihil innovando*, having proved that the right of Gandia to all the water of the river Alcoy, dated from time immemorial.

It has already been said that the *hila*, or measure of water used in irrigating the valleys of Eastern Spain, is different in almost every centre of irrigation. In Murcia and Orihuela it is an exact measure of the cubic contents of a column of water fifty yards long by a vertical section of thirty-two square inches In Elche and Novelda it is an imaginary measure, being a certain fraction of the whole volume of a canal, whether the water be high or low. In Gandia this

artificial measurement is unknown, yet the size of the Gandian *hila* differs from that of Murcia and Orihuela. The *hila* of Gandia is the volume which will flow through an outlet eight inches square at the rate of one yard per second, or double the size of the Murcian *hila*.

The Alcoy and Bernisa rivers unite at a distance of several miles above Gandia, and their joint waters flow through the garden in a north-east direction to the sea.*

Three anicuts or *azuds* are thrown across the Alcoy and Bernisa, for raising the water. The *Azud de Alcoy*, near Villalonga, has been there from time immemorial, and has always been repaired by the cultivators who receive water from its canals. The *Azud de En-March* is a short distance lower down, and intercepts the water which escapes over that of Alcoy. It was constructed by the Lord of Beniarjó, whose name was Mosen March, in 1500 A.D. The third anicut, called the *Azud de Bernisa*, is a work of Moorish times.

* *Villages of the huerta de Gandia*

On the left bank of the river.	*On the right bank of the river*
1. Gandia	1. Beniflá
2 Beniopa	2. Beniarjó
3. Benipeixcar	3. Alqueria de la Condesa
4. Beniredra	4. Bellreguart
5. Real	5. Palmera
6. Palma	6. Ador
Near the sea shore	*At the foot of the southern hills.*
1. Piles	1. Potries
2 Miramar	2 Fuente de Encarroz
3 Guardamar	3. Oliva
4 Daimús	

They are all solidly built of rough stone work and lime; but they are much out of repair, and require a thorough overhauling.

The channel flowing from the south side of the *Azud de Alcoy* is called the *Azequia de Alcoy*, and it conducts the whole volume of water to a vaulted reservoir called the *Casa Fosca*, the keys of which are kept by the towns of Gandia and Oliva. Here there is a stone wall with seven outlets for dividing the water. Two of these outlets convey water to the channel of Rebollet, which irrigates the villages of Potries, Fuente de Encarroz, and Oliva; and the others admit the remaining water into another reservoir, 500 yards lower down the valley, called the *Casa Clara*. Here the water is divided by twenty-five separate outlets, ten of which discharge the water which supplies the canal of Gandia, and irrigates eight villages, having a cultivated area of 8884 *fanegadas*.* The other fifteen outlets of the *Casa Clara* discharge the water to supply the canal of Oliva, which also irrigates the land of eight villages, comprising 13,290 *fanegadas*. A small canal, that of Encarroz, is taken from the north side of the Azud de Alcoy, and irrigates 1266 *fanegadas*.

A canal of the same name flows from the Azud de En-March, which was the subject of a forty years' lawsuit (A.D. 1506-46) between the villages of Beniarjó and Palma The last canal is that of Bernisa. The whole area irrigated amounts to 35,556 *fanegadas*, and the irrigating channels turn two mills

* One *fanegada* = 1·13 acre

There is no code of ordinances approved by the Government, for the regulation of Gandia irrigation, but all disputes and other questions are settled by rules and customs which have been handed down from the time of the Arabs.

When any business has to be discussed and settled relating to the water derived from the *azud* of Alcoy, the representatives of the municipalities, whose villages are interested in it, assemble in the house of the Alcalda of the village of Palmera. The representatives or Syndics of the villages then state their views according to a long-established order of precedence, he of Gandia opening the debate. The same order is observed in the other villages, in regulating the affairs of their respective *azequias*.

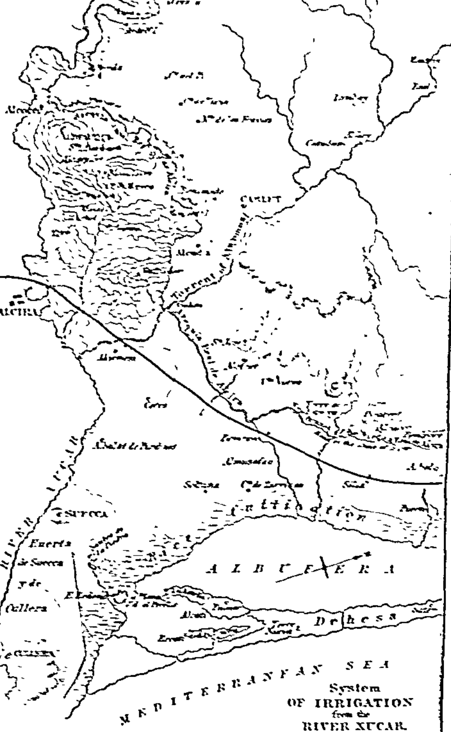
Three *Azequieros* are appointed by the municipalities to superintend the different channels. Their duties are to denounce to the Alcaldes any infraction of rules or improper use of water, to receive the sums of money paid as fines, and to regulate the distribution. Their staff of office is a long pole with an iron hook at the end, called the *dall*. The cultivators also elect officers called *Regantes*, one for each channel of irrigation, to watch over their interests, and to announce to each cultivator the hour when his *tanda* or turn comes round.

The channels are cleaned out every year in the month of May. The villages are bound to assist, either with money, material, or labour, and the village of Fuente de Encarroz must furnish the wood for making temporary dams. But there are four villages, Rafel-

cofer, Palmera, Alqueria de le Condesa, and Beniflá, which claim total exemption from giving any aid whatever in this important work. The three former villages allege, as the ground of exemption, that when the Moorish Chief of Gandia was blockaded in the castle of Rebollet, and they succoured him with supplies of water, he exclaimed :—"*Hau regat y regareu, y al azud no anireu.*" The people of Beniflá found their claim on a similar tradition. They say that when the Duchess of Gandia was passing their village, on one very hot day, she asked for a drink of water, which was presented to her in a glass pitcher. She was so grateful for this relief to her thirst, that she too exclaimed .—"*Beniflá rega y regara, y al azud no anira.*"* These villages stick most pertinaciously to their privileges, and oblige their neighbours to do all the work, while they reap the benefits. The other Gandian villagers must assuredly be very easy, good-tempered people to pay so high a price, without demur, for the drinks of the thirsty Moor and still more thirsty Duchess.

The people of Gandia complain very much of the number of anicuts which have been built across their rivers before they reach the garden, in spite of the decree of *nihil innovando* obtained by their Duke in 1689. This, and the dilapidated condition of the *azuds*, have diminished the supply of available water very much of late years.

* "Beniflá shall irrigate and continue to irrigate, and shall not repair the *azud*"


Torrent of Algemesi
Acequia Real de Alcira
ALCIRA
RIVER XUCAR
SUECCA
Huerta
de Suecca
y de
Cullera
Cultivation
ALBUFERA
Dehesa
MEDITERRANEAN SEA
System
OF IRRIGATION
from the
RIVER XUCAR.

IX.

IRRIGATION FROM THE RIVER XUCAR

THE river Xucar rises in the mountains of the province of Cuenca, flows through a deep ravine to Antella, then irrigates and fertilizes the region between Antella and the sea, forms an island round the ancient town of Alcira,* and falls into the Mediterranean at Cullera, south of the great Albufera lake, and about twenty miles south of the city of Valencia.

The Xucar irrigation is an instance of the mischief that selfish speculators and doctrinaire centralizers may do, by interference with the ancient rights of the people. The Xucar irrigation was, but is not now, among the best in the eastern valleys of Spain; and, although it possesses the finest modern engineering works, neither its mode of government nor its system of cultivation is now to be admired.

The Arabs of the Valencian kingdom threw an ani-cut across the Xucar near Antella, and extended their

* *Jezira-Shukar* of the Moors. "The island in the Xucar." *Al Makkari*, i, p. 68.

irrigation mainly over the country on the left bank of the river. On the 31st of December, 1239, Jayme I of Aragon conquered Alcira and its irrigated garden, and divided the land amongst his followers. In 1273 he granted the privilege of using the water of the canals to the inhabitants, reserving a small tax, and the nomination of irrigation officers. Subsequently the privilege of electing the officers was conceded to the inhabitants of Alcira, and in 1469 Juan II of Aragon granted a jurisdiction without appeal, in matters relating to irrigation, to the Judge elected by the people.

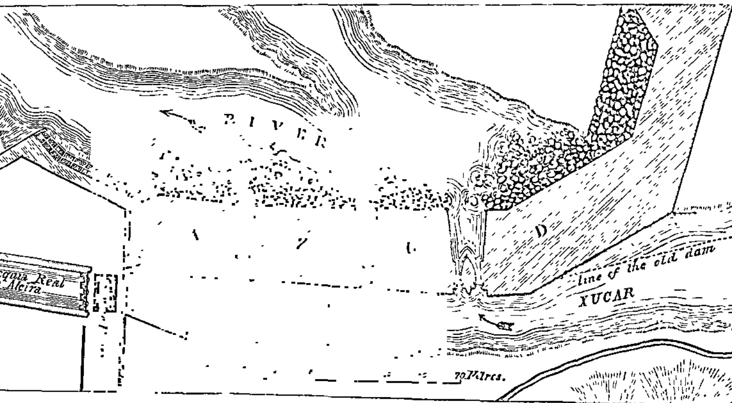
The towns of Alcira and Algemesi, by virtue of these privileges, nominated the four officials who composed their Irrigation Tribunal. These were the *Juez Azequiero*, the *Procurador Sindico*, the *Escribano* or clerk, and the inspector of accounts. The *Juez Azequiero* had exclusive jurisdiction over all suits, processes, and informations relating to irrigation; granted the necessary funds for repairs; inspected the channels, and in fine exercised complete and independent jurisdiction over the irrigation works. It was the duty of the *Sindico* to watch over the privileges and interests of the people. The *Escribano* recorded all judicial sentences, and all matters relating to the canals; and the inspector of accounts had charge of all funds, inspected the canals, reported irregularities, and denounced transgressors.

These officers were elected every year, and immediately afterwards the General Council of Irrigators was summoned by the Juez Azequiero. This assembly

decided upon the sum of money which would be required for the year, to pay the expenses of administration, the charges for repairs and the salaries of officials. This sum was then apportioned amongst the cultivators, according to the number of their acres

This excellent system, which left the management of the irrigation entirely in the hands of the people, continued in full force until the middle of the last century. Then, unluckily for the dwellers on the banks of the Xucar, a powerful grandee became a grasping speculator. The Duke of Hijar, who enjoyed twenty-eight other titles* and thirteen surnames, proposed a scheme to the Government in 1767, for extending the royal canal of Alcira at his own expense, on condition that the cultivators paid him one-twentieth of the value of their crops, in addition to the usual irrigating charges. Not only were the people themselves not consulted, but, in order to secure the interests of the Duke, those of the people were unjustly and shamefully set aside. The irrigation officials were suspended, a Judge with full and independent jurisdiction, named Casamayor, was appointed by the Government to assume all the powers so long exercised by trusty men elected by their townsmen, and the old free institutions were abolished Casamayor held this office, with the title of *Juez Delegado*, from 1767 to 1778. He retained some of the ancient usages, but jobbery and corruption became the order of the day, and the number of officials was multiplied A house, called the *Casa del Rey*, was built for them at Antella by the

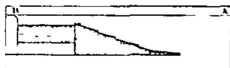
* *Berni, Titulos*, xv. 43


RIVER
D
line of the old dam
XUCAR
Real
Alcira

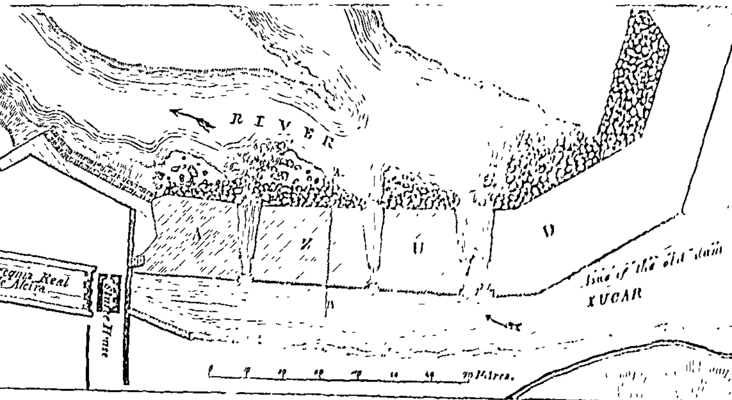
Duke of Hijar. From that time the *Azequiero* of the Royal Canal of Alcira has held a very lucrative post. Don Lorenzo Rosillo succeeded Casamayor as *Juez Delegado* He held the office from 1778 to 1801, and during his time some fine public works were completed, especially at the azud of Antella In 1817 the office of *Juez Delegado* was abolished, and since that time there has been a *Sub-delegado* at Alcira, under the local authorities of Valencia, with twelve *alquazils* or guards under him; and the canal fines are divided between this official, the denouncer, and the Government. The good old order of things, as it was handed down from Moorish times, and which is still preserved in other irrigated gardens, has thus been destroyed for ever in the fertile valley of the Xucar.

The Royal Canal of Alcira is drawn from the river Xucar, by means of an *Azud* or dam, close to the village of Antella. *(See engraving on opposite page)*

The *Azud* is built between two rocky spurs, at a point where the river takes a sharp turn It was completed at the end of the last century, but there was an older structure on the same site in the time of the Moors. It consists of a massive wall of stones and cement, resting on a reef of rocks in the river bed, and is divided by three sluices through which the surplus water flows, the discharge being regulated by



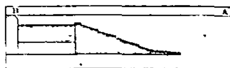
flood-gates. The section of the Anicut from A to B on the plan opposite is here shown


RIVER
XUCAR
Sluice House
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Z
U
D

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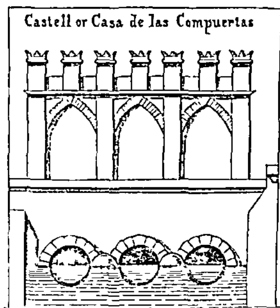
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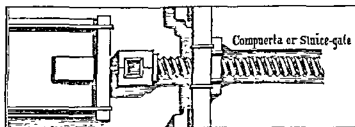


flood-gates. The section of the Anicut from A to B on the plan opposite is here shown.

The Royal Canal of Alcira flows off just above the anicut, on the left bank. At the outlet there is a build-



ing on three arches called the *Casa de las Compuertas,* built over the sluices of the canal. It contains the screws by which the three sluice-gates are raised and



lowered, and the discharge of water into the canal can easily be regulated by one man. Long wing walls, on either side of the canal, protect the banks from the action of the water.

The Royal Canal of Alcira shapes its course for a long time close to the left bank of the river, then skirts the rocky range of hills above Alcudia to Alginet, passing under a ravine, through a siphon 150 yards long, called the *Cano de Algemesi.* The lower part, from near this point to Albal, is the continuation constructed by the Duke of Hijar. The country composing the island from Antella to Algemesi, between the river and the canal, is one vast network of irrigating channels. There are, besides the outlets for these secondary channels (all fitted with flood-gates, of which the guard keeps the keys), as many as 102 masonry works of different kinds, tunnels, aqueducts, protecting walls, etc., connected with this canal

The extent of country irrigated by the Canal of Alcira is shown on the map To the south it is bounded by the river Xucar; to the north by the ravine of Catarroja, by which it is separated from the garden of Valencia; to the east by the Albufera lake; and to the west by the mountains of Carlet.

It is a land of orange gardens, almonds, vines, and pomegranates; but its chief and most valuable product is rice, the paddy fields extending chiefly round the *Albufera.** This lake, about nine miles in circumference

* Derived from *Al-Buheirah*, the diminutive form of *Bahar*, "a small sea"

"Near Valencia," says Al Makkari, "there is a large lake, which reflects the rays of the sun in such a manner that the light in the city is increased by it. This, indeed, is a fact to which all authors who have written upon Valencia bear ample testimony." (i, p. 67)

Marshal Suchet took his ducal title from the lake of Albufera.

and from six to twelve feet deep, is separated from the Mediterranean by a narrow strip of sand. In the winter it abounds with a great variety of wild ducks and other aquatic birds, of which there is a complete stuffed collection in one of the rooms of the university at Valencia. The cultivation of rice around the shores of the Albufera was introduced by the Arabs, and was prohibited, on account of its unhealthiness and the waste of water it occasioned, by King Martin of Aragon in 1403 A.D. Permissions and prohibitions have alternated since that time, and Cavanilles recommended the total discontinuance of a cultivation which produced so many fevers and such swarms of mosquitoes.* Attempts have been made, near Valencia, to grow rice without irrigation, but they were fruitless.

It would certainly appear that, apart from its extreme unhealthiness, the cultivation of rice in this country is open to serious objections The continuous harvests and incessant swamping wear out and enervate the land, and now the use of guano and other manures is essential. The rice is sown in April and May, and reaped in September; so that the swampy land is seldom exposed to the influence of heat, and the stagnant water keeps it in a constant state of saturation, and rapidly neutralizes its fertilizing properties. At present the cultivation of rice is very strictly prohibited, beyond certain prescribed limits,

* One of the Moorish poets of Valencia says—"There is one thing which annoys me most, and puts me out of humour, which is, that the fleas are continually dancing to the music of the mosquitoes" *Al Makkari*, i, p. 67.

and the use of guano as manure is believed to have decreased the pernicious effects of the swamped land, though in what way it is difficult to understand.

Besides the Royal Canal of Alcira, the Xucar system of irrigation includes the Canals of Castellon, Antella, and Carcagente, and waters 49,065 acres, of which 32,852 are under rice cultivation It is calculated that a *hila* (or *muela*, as it is called here) of water irrigates about 400 acres; and as the four canals have a volume of—

Castellon - - - - - -	50 *hilas*
Antella - - - - - -	12 „
Carcagente - - - - -	66½ „
Real de Alcira - - - -	618 „
	746½

about 495 are absorbed by the rice fields. The *hila* of the Xucar valley is a column of water twenty-five yards long, with a vertical section eight inches square.

X.

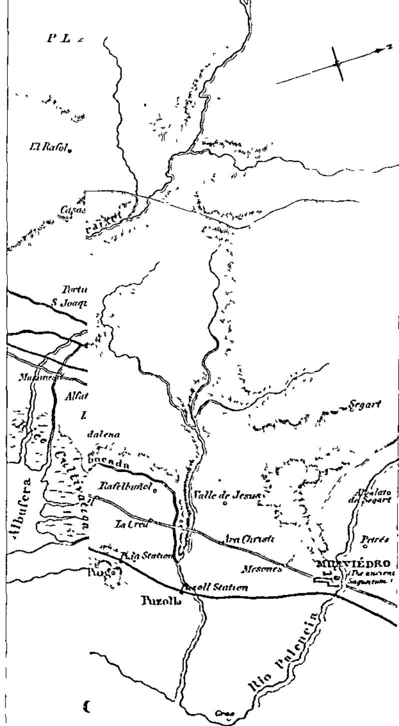
THE GARDEN OF VALENCIA.

FROM the lofty Miguelete tower, in the centre of Valencia, there is a glorious view of the richest and most completely irrigated *huerta* in Spain. A vast expanse of brilliant green is dotted with villages, with the Mediterranean to the eastward, and a belt of rocky mountains, some very distant, in every other direction. The river Turia or Guadalaviar,* the creator of all this fertility, flows round the northern walls of the city, where it is faced with *malecones* or masonry quays of the time of Philip II† and his son, and crossed by four bridges. It empties the few drops which are left by the irrigation into the Mediterranean, close to the *Grao* or seaport of Valencia.

Valencia was famous for its irrigated *huerta* from the earliest Moorish times. The Arabs called it the *Medinatu-t-tarab* or "City of Mirth"; and *Al mityabu-*

* The "white river."

† Those on the left bank were built between 1606 and 1674, and those on the right between 1598 and 1729.



P L
El Rafol
Casas
Portu
S. Joaq
Alfat
L
dalena
Segart
Albufera
Rafelbuñol
Valle de Jesus
de Segart
La Creu
Ara Christi
Petrés
MURVIÉDRO
Mesones
The ancient Saguntum
Puzoll
Rio Palencia

l-Andalus, "The scent-bottle of Andalusia," from its numerous orchards and flower gardens. Here was a *Rissafah** or pleasure ground laid out in flower-beds and shady walks, in imitation of the *Rissafah* planted by the Caliph Abd-er-rahman at Cordova, which in its turn was called after similar pleasure gardens at Damascus. Here, too, was the *Munyatu-ibn Abi Amir* (the garden of Abi Amir), planted by a grandson of the famous Almanzor Here, too, were a thousand other pleasant gardens and alcazares, all fertilized by watercourses from the river; and we may gather, from poor Conde's† confused mass of chronicles, that the dams and irrigation canals were constructed during the long and prosperous reigns of the earlier Ommiad Caliphs. Afterwards, what with the raids of that cruel and treacherous free lance the Cid Campeador; what with invasions by Almoravides, Almohades, and Christians; and what with civil commotions, the garden of Valencia saw little peace, during the last century or two of its Mohammedan days. But the wise institutions and admirable irrigation system of the earlier Arab rulers had taken such root that they stood firm through all this, and have lasted even to our day.

In the year 1238 the Arab poet sang his elegy on the fall of Valencia, from the top of the eastern gate;

* Literally, "a place paved with flags, or made flat." Hence the Spanish *Arrecife* (a causeway). *Gayangos.*

† Conde, the author of *Dominacion de los Arabes en España*, was persecuted, and died in great poverty, leaving his work incomplete, for having acted as Joseph Bonaparte's librarian.

and the conqueror Jayme I. of Aragon planted his red and gold bars over the palace of the last Moorish king. The land comprised in the beautiful garden was divided amongst his followers. This Christian king and his rude soldiers were far behind the conquered people in knowledge of agriculture and of all the arts of peace. But, fortunately for Valencia, King Jayme was not so ignorant as to be incapable of comprehending his inferiority; and one of his first decrees related to the preservation of the Arab system of irrigation. "The waters shall be taken and used," he commanded, "in the order that was established in old times, according to the rules framed by the Saracens."*

In 1239 King Jayme conceded to the cultivators of Valencia, for all time, the free use of all the canals and irrigating watercourses, except the Royal Canal of Moncada, and on May 8th, 1268, he also granted this Royal Canal to the people, reserving certain rights of the crown. The canal is now the property of the community receiving water from it. As this canal, which irrigates the country on the left bank of the river Guadalaviar, is thus on a distinct footing; I propose to describe it first, before entering upon the general system of Valencian irrigation, with its eight other canals

The Guadalaviar (or white river) rises in the mountains in the southern part of Aragon, and no less than twenty-three dams are thrown across it, each with an

* The words, in his barbarous Limosin dialect, are—"*Presiats aquelles aigues segons que antiguament es è fo stablit è acostumat en temps de Sarrahins.*"

irrigating canal, before it reaches the garden of Valencia It is unnecessary to enumerate them all, but at a distance of four miles above the city, when the river enters the famous *huerta* of Valencia, the twenty-fourth *azud* or anicut is that of Moncada

The *azud* of Moncada is a mass of lime and rough stones built across the river, opposite the small town of Paterna. The water of the river falls over the five steps in which the down stream face of the dam is built, and at one end there is a scouring sluice. The Moncada canal flows off a few feet above this sluice, and a small house, with lock and key, is built over the *tablones* or flood-gates which regulate the supply of water. The part of the canal between the river and the *tablones*, called the *almenara*,* is faced with masonry. From this point the canal flows to Pozul, near the sea, and at certain intervals there are outlets by which surplus water can either be allowed to flow back into the river, or be sent to make up the volume of other canals that may require it. By means of these *almenaras*, of which there are seven, the canal is emptied, when it becomes necessary to clean it out. All the outlets for distributing water for irrigation are faced with masonry, but they differ in shape and size according to the extent of land that is to receive water from them Each of these openings, of which there are no less than 224, has a separate name.

Half way between Paterna and Moncada, a deep

* A word of Arabic derivation, meaning a channel conveying surplus water from an irrigating channel back to the river, or to another channel.

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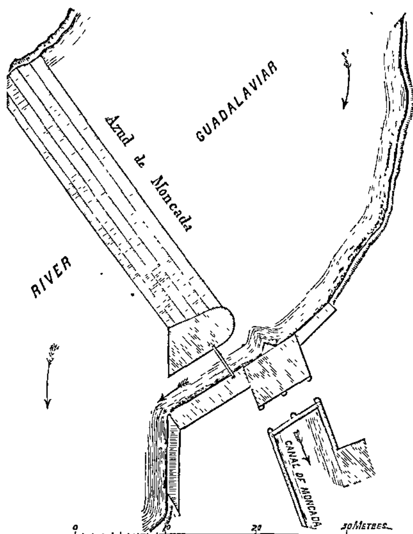
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Half-way between Paterna and Moncada, a deep

* A word of Arabic derivation, meaning a channel conveying surplus water from an irrigating channel back to the river, or to another channel.

ravine crosses the course of the canal, down which a torrent occasionally rushes; and in order to avoid the



floods, the canal is taken under the bed of the torrent by means of a masonry siphon, called a *cano.**

* *Salto di Gatto* (Cat's leap) of the Italian engineers.

The Moncada canal turns ten mills, and irrigates the land of thirty-four villages, measuring three leagues in length by two wide, with forty-eight *filas* of water.

A fixed rate is paid by each cultivator for water from the canal, according to the number of *jovadas** irrigated, half for maintenance of the works, and the other half as a fiscal charge imposed by right of the reservation made by the Conqueror Jayme I The government of the Moncada Canal is entrusted to the cultivators.

From time immemorial this government has consisted of twelve *Jurados* or *Regidores* nominated annually from amongst the following twelve villages, which originally received water from the canal

1. Paterna	7. Museros.
2. Moncada	8 Vinalesa
3. Alfara del Patriarca	9 Masamagrell
4 Foyos	10. Puig.
5. Albarat dels Sorrells	11 Puzol
6. Meliana.	12 Burjosot

The twelve Jurados elect a Judge of Irrigation called the *Accquiero Real*, who must be a man of known integrity, a cultivator of land irrigated from the Moncada canal, and owning no land irrigated by any other canal. This official and the twelve *Jurados* take cognizance of all questions and disputes relating to the division of water, to any mischief done to the

* The Valencian land measure is as follows:—

1 Jovada	=	6 Cahizadas
1 Cahizada	=	6 Fanegadas
1 Fanegada	=	1 1 Acre

works, to the imposition of fines, the decision of claims, and the receipt and disbursement of irrigation funds. The privileges under which they act were conceded by Jayme II of Aragon in 1326, and by Peter II in 1329; and are now embodied, together with other rules which have been issued from time to time in more modern times, in the "*Ordinances for the good government and maintenance of the Royal Canal of Moncada, and the distribution and use of its waters*", consisting of 540 chapters.

The *Jurados* also elect the other irrigation officials, namely, the *Veedores* or appraisers, who assess damages and estimate expenses; and the *Escribano* or secretary, who must also be a cultivator receiving water from the canal. The *Acequiero Real* nominates two officers and four guards, whose duty it is to keep constant watch over the works; but these nominations are subject to the approval of the *Jurados.*

We now come to the eight other canals of the garden of Valencia. They are united under a common jurisdiction which is exercised by a singular Tribunal of great antiquity; and as much interest must always attach to the Valencian system of irrigation, I will describe it in some detail.

The names of the canals are—

On the right bank	On the left bank
of the river Turia.	
1-2. Cuarte and Manises.	6. Tormos
3. Mislata.	7. Mestalla.
4. Favara	8. Rescaña
5. Rovella.	

1-2.

The Canal of Cuarte and Manises flows round the extreme edge of the irrigated area, to the ravine of Catarroja, and finally empties itself into the Albufera. On its right bank, from the river to the ravine, is the extensive unirrigated plain of Cuarte on a high level, and covered with algarrobos, olives, and corn; and it is not until it approaches the Albufera that the canal begins to distribute water for irrigation from both banks. The *azud* of the Canal of Cuarte is thrown across the river, at a short distance below that of Moncada, which it closely resembles in all respects.

The volume of water to which the Cuarte Canal is entitled amounts to fourteen *filas*;* and this quantity suffices, by dint of much watchfulness and economy, for the irrigation of the lands of twelve villages. Nine secondary channels send off a network of smaller water-courses; and each channel is superintended by an officer elected annually by the cultivators whose

* In Valencia there has been some difference of opinion as to the exact dimensions of a *fila*. Some authorities will have it that a *fila* is the volume necessary to turn the wheel of a flour mill. Others that it is an opening through which water flows, of the dimensions of a square Valencian *palmo* = 8·346 inches. The *Peritos* or appraisers of irrigation works consider a *fila* to be the volume of water enclosed between two vertical sections one *palmo* square, in a length of 22 feet; at an inclination and with a head of discharge causing it to flow out in one minute. This would make it about the same as a Murcian *fila*. Others say that a *fila* is the quantity of water which will flow through an opening a *palmo* square, for a distance of four *palmos* in a second. All agree that a *fila* is a quantity sufficient to irrigate 400 *fanegadas* of land.

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The volume of water to which the Cuarte Canal is entitled amounts to fourteen *filas*;* and this quantity suffices, by dint of much watchfulness and economy, for the irrigation of the lands of twelve villages. Nine secondary channels send off a network of smaller water-courses; and each channel is superintended by an officer elected annually by the cultivators whose

* In Valencia there has been some difference of opinion as to the exact dimensions of a *fila*. Some authorities will have it that a *fila* is the volume necessary to turn the wheel of a flour mill. Others that it is an opening through which water flows, of the dimensions of a square Valencian *palmo* = 8·316 inches. The *Peritos* or appraisers of irrigation works consider a *fila* to be the volume of water enclosed between two vertical sections one *palmo* square, in a length of 22 feet; at an inclination and with a head of discharge causing it to flow out in one minute. This would make it about the same as a Murcian *fila*. Others say that a *fila* is the quantity of water which will flow through an opening a *palmo* square, for a distance of four *palmos* in a second. All agree that a *fila* is a quantity sufficient to irrigate 400 *fanegadas* of land.

land is irrigated by it. The village of Manises is separated from Cuarte by a deep ravine, over which the canal is conducted on an acqueduct constructed by the Arabs. It is 240 yards long, and consists of twenty-eight arches, the highest, which is also the central one, being thirty feet in height. Massive walls of stalactites have been formed under the arches in the course of centuries, and bushes find a footing between the stones; so that the time-worn old structure looks more like a work of nature than one of art The ordinances of the Canal of Cuarte are based on the regulations of the Arabs, and were finally approved and printed by the Spanish Government in 1709. The municipality of the villages nominates three persons for the office of *Sindico*, one of whom is elected by the whole body of cultivators to serve for two years. The two other nominees, together with four more elected by the cultivators, are at the same time nominated to hold office as the six *Electos* of the Canal of Cuarte. The duties of the *Sindico* are to superintend the collection of dues and fines, to look to the maintenance of the works, and especially to watch the effect of freshes in the river, on the *azud*. Under him there is a *Collector*, whose business it is to keep a list of the tenants with the quantity of land cultivated by each, and of water received for irrigation. The *Collector* receives and keeps an account of all dues and fines There is another official who personally superintends the repair of the *azud*, the house over the sluices, the *almenaras* with their gates, and the canal. He also regulates the volume of water in the canal, according to orders re-

ceived from the *Sindico*. When there is a fresh in the river, it is his duty to close the sluices, to prevent silt from being washed into the canal. Fines are imposed on all cultivators who take water surreptitiously, allow it to run to waste, or fail to clean their portion of the channels The mode of electing the irrigation officers, and the rules embodied in the Ordinance, had been observed, as unwritten law, from time immemorial, by the cultivators of Cuarte and Manises

3.

The Canal of Tormos flows parallel to the Royal Canal of Moncada, on the left bank of the river, and passes under the ravine of Carcaixent by a siphon. The *azud* is built of solid masonry, with a fall broken into five steps. It is seventy-eight yards in length and thirteen feet wide. The officers and rules of the Tormos Canal are the same as those of Cuarte. It is entitled to twenty *filas* of water from the river.

4.

The Canal of Mislata flows from the right bank of the river, across the garden of Valencia, to the ravine of Catarroja It irrigates the most fertile portion of the garden, and is one of the most important sources of irrigation. Its government is entrusted to two *Sindicos* or *Acequieros*, eight *Electos*, a Chief Guard, and four *Veedores*. The Ordinances of the Mislata Canal were finally approved by the Government and printed in 1751. It is entitled to ten *hilas*.

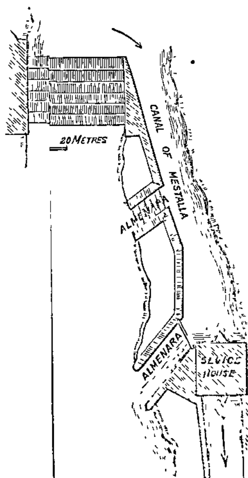
5.

The Canal of Mestalla, on the left bank of the river, irrigates the low land between the Tormos Canal and the river banks. I made a more minute examination of the Mestalla *azud* than of any of the others. It is only a few yards below that of Mislata, and is of solid masonry. On the right bank it rests upon a massive wing wall of sufficient height to restrain the floods; and on the left bank there is another wall, the outer side of which forms one side of the first part of the canal. Here there are two *almenaras* or calingulas for discharging surplus water and getting rid of silt. Their mouths are closed by large beams fitting into grooves in the masonry, and the silt had formed up to the crest of the walls. The beams are periodically removed, and the silt is discharged into the river. A small house is built over the two sluice gates on the canal, where the volume of water is regulated by one man, working the screws. The *azud* is twenty feet in thickness, and the down stream face is built in six steps. Its length from bank to bank is eighty yards. (*See* PLATE.)

The Canal of Mestalla is entitled to fourteen *filas* of water. Its Ordinances were confirmed by the Government in 1771, and consist of 123 sections.

6.

The Canal of Favara, taken from the right bank of the river, is soon afterwards separated into two main branches, flowing across the garden of Valencia to the lake of Albufera. It is also entitled to fourteen *filas*.


20 METRES
CANAL OF MESTALLA
ALMENARA
ALMENARA
SLUICE HOUSE

To fac

The Favara Canal sends off ten secondary channels, each branching into three smaller ramifications It also supplies the Rovella Canal with a certain portion of its volume, and the cultivators interested in the latter canal have, in consequence, to pay one-third of the expenses of that of Favara

7

The Canal of Rascaña is the last on the left bank of the river It crosses the Mestalla Canal and discharges its surplus waters into the Canal of Tormos.

8.

The Canal of Rovella is the last on the right bank, and is used for flushing the sewers of the city of Valencia, and to irrigate the gardens within the walls.

These eight canals, together with that of Moncada, receive 138 *filas* of water, and irrigate nearly three square leagues in the beautiful garden of Valencia.

Each canal has its separate code of Ordinances, and is governed by its own officers elected by the general body of cultivators. The *Sindicos* or *Acequieros* of the eight canals form a tribunal which takes cognisance of all matters relating to irrigation, and from which there is no appeal. It is called the *Tribunal de las aguas* or *Cort de la Seo.** "Happy the country", exclaims Jaubert de Passa, "in which each individual may be called upon to perform the duties of a Judge"!

* From the place of meeting being at the door of the Seo or cathedral.

The eight Judges, forming the *Tribunal de las aguas*, assemble once a week, on Thursdays at noon, under the door of the cathedral at Valencia, where they sit in a row, on a bench in the open air. Here a succession of rural judges, elected annually by their fellow labourers, has sat in judgment every week from time immemorial. Before the cathedral was built they sat at the door of the mosque, and the origin of the Tribunal is referred, but on doubtful authority, to the reign of the Caliph Alhaken II, A.D 961-76.

The Court is protected by no soldier nor policeman; it has no porter, nor clerk, nor officer of any kind, and no advocate pleads before it. A circle is formed round the door of the Apostles, and in the midst of deep silence the Judges take their seats. The guards of the different canals then denounce any of the receivers of water who may have broken any clause of the Ordinances, and announce any disputes between cultivators themselves, which are to be heard. The persons who are cited, then present themselves in an established order, and their cases are disposed of. The accused stands forward, the guard states the complaint, and the Judge, who is the *Azequiero* of his canal, hears what the accused has to say, and cross-examines any witnesses that may be called. The *Azequiero* of the canal in question then stands on one side, and after the other Judges have consulted in a low voice, one of them pronounces judgment, and declares the sentence. It is almost invariably received by the accused in profound silence, and with a respectful bow; but, if he objects, the fine is doubled, and any further contumacy

involves total exclusion from the list of irrigators. In disputes between cultivators the same order is observed. If the person accused of any infraction of the irrigation laws is a nobleman or powerful landlord, the guard of the canal reports the matter to the magistrate, who proceeds to the house of the accused on the following Thursday, and conducts him to the Tribunal, saying to the Judges:—"The Guard of such a Canal has informed me of the accusation against the person who accompanies me, and I am come to place him at your disposal. Administer justice, and I am here to see it enforced."

The Judges form their decisions upon the Ordinances of the different canals, and are generally allowed to be patient hearers of evidence, dignified, calm, and just. Indeed the Tribunal is so popular that people often try to bring disputes before it which do not strictly relate to irrigation, in their desire to avoid the expensive justice of a more regular court.

From the decisions of the *Tribunal de las aguas* there is no appeal.

A Tribunal administering justice without expense, and so completely representing and securing a system of self-government, was sure to find enemies amongst the despots, lawyers, centralizers, doctrinaires, and democrats of all ages. The Bailes* of the Kings of Aragon attacked it by declaring that all justice should emanate from the royal bounty, especially in a conquered country. After the union of the crowns, lawyers and statesmen made several attempts to destroy

* A crown officer in Aragon.

the liberties of the irrigators of Valencia; but it was from the democrats of the Cortes of Cadiz that the free institutions represented by the *Cort de la Seo* stood in the greatest danger. That learned and patriotic Valencian, Don Xavier Borrull, defended the Tribunal in a most eloquent and interesting speech before the Cortes, at the end of which he moved "that the *Azequieros* of the garden of Valencia should continue to take cognizance, as they had done until then, of all matters relating to the waters of the canals, to irrigation, and to damage done to irrigation works". Fortunately the eloquence of Señor Borrull made a deep impression on his audience, and the continued existence of the *Tribunal de las aguas* is due to his exertions. This admirable institution still flourishes as it did in the time of the Arab Caliphs, and it is, so far as I have been able to learn, unique in modern Europe.

The crops of the garden of Valencia, besides all kinds of fruits and vegetables, consist of Indian corn, alfalfa, wheat, flax, hemp, and beans. I also saw a fine field of cotton near the wing wall of the Mestalla *azud*, raised from seeds procured in Algiers. The fruits are almonds, grapes, oranges, figs, dates, and mulberries. Centuries of irrigation are said to have diminished the flavour of Valencian fruits and vegetables, though I cannot say that I found them inferior to those in other parts of Spain. The people are clever and sharp-witted; but it is a word and a blow with them; a very slight thing throws a Valencian into an ungovernable fury; and there were several bad stabbing cases during the short time that I was at Valencia The

land belongs to noblemen and other proprietors residing in the city, and is let out in small lots to tenant cultivators, as in the garden of Murcia. The tenants pay a certain rent, but otherwise they are quite independent, and give away portions of their holdings, *of course with a proportional charge on them*, to their children on marriage Nor is it either a safe or an easy thing to eject a tenant. When such a threat is used, the tenant will probably reply that he would like to see the *guapo* who will occupy his land; and if the threat is carried into execution, a sharp knife usually ends the dispute. But these head-strong peasants are excellent practical farmers, and their cottages are exceedingly neat and clean both inside and out. The Valencian cottages are all on one pattern. They have whitewashed walls with a door shaded by a vine trained over a verandah, and three narrow windows above it, in the gable, and a neatly-thatched roof with small wooden crosses over each end. The door-posts, and frequently the interior walls, are ornamented with the glazed tiles for which Valencia has always been famous.* The large room into which a visitor is admitted, is always very clean, and well furnished.

During my examination of the Valencian system of irrigation, I received much assistance from Don Pedro Salvá, who possesses the finest library in the city; and

* The *azulejos*, or glazed tiles of Valencia, form a branch of industry which has been handed down from the time of the Arabs The clay is brought from the village of Manises, where there is also a manufactory of all kinds of earthenware The *azulejos* generally have blue or purple flowers on a white ground

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from the learned Don Vicente Boix, the Chronicler of Valencia, to whose care and judgment are due the preservation of the ancient towers and gateway, and other objects of antiquarian interest. The latter kindly accompanied me to some of the irrigation works, and assisted me to understand the scarcely intelligible Lemosin of the villagers. I take this opportunity of offering to these gentlemen my grateful acknowledgments.

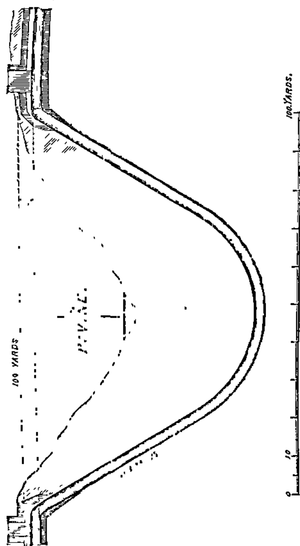
XI.

CASTELLON, VINAROZ, AND BENICARLÓ.

North of Valencia there are some fine works of Moorish origin, which supply irrigation to the gardens of Almazora and Castellon de la Plana, from the river Mijares. Here the Arabs formed one of the richest *vegas* in the wide dominions of the western Caliphs. After the country was conquered by the Aragonese, the cultivators on the banks of the Mijares groaned for some years under the exactions of their feudal tyrants, until in 1346 King Pedro of Aragon conceded to them the free use of water from the river. On the left bank 26,000 acres are irrigated in Castellon, and 22,500 in Almazora; and rather more are under irrigation on the right bank, in Villareal and Burriana.

In very remote times the *azud* or dam, for the canal which is common both to Castellon and Almazora, was thrown across the river Mijares, about two-thirds of a mile above the bridge of Villareal. It rests on rocks in the bed of the river, which is here 108 yards across, and there are two escape weirs for surplus water. The water is then led along a subterranean aqueduct, 433

yards long, to the great ravine or *rambla de la Viuda*. The obstacle of the ravine is overcome by means of a



siphon or *cano* which conducts the water under it, the distance from one side to the other being 109 yards.

This is a most remarkable work of Moorish times. The tunnel is two yards in diameter, and is excavated in the rock for a depth of thirty yards below the bed of the torrent. The length of the curve is 169 yards, and the difference of level from one side to the other is thirteen feet; so that the pressure on the square inch is equal to 5.59 lbs.* From the ravine the water is led by tunnels cut in the rock, and under the brow of the old fortress of Almanzor, for a distance of 800 yards. The whole volume of water in the canal then passes under a house on the banks of the river, where two strong iron flood-gates separate it, and regulate the supply for the canals; one for the irrigation of Almazora, and the other for that of Castellon.

The cultivators who are interested in the Castellon system of irrigation are formed into a *gremio* (guild or association), which elects twenty-four *Sindicos* for the administration of their affairs. A third of these take office every third year, and watch over the maintenance of the works and the distribution of water. The printed Ordinance for the irrigation from the Mijares is divided into sixty sections.

The country between the Mijares and the mouth of the Ebro is naturally barren and arid. But the extra-

* The first time a siphon was used is supposed to have been in the aqueduct between the springs of Mount Pila and Lyons, the date of which was about 40 A.D. On this aqueduct there were three siphons. One of them, across the valley of Chaponest (2,400 feet), was 200 feet deep, and the difference of level between the two sides was 20 feet. The pipes were of lead. Vitruvius describes the use of the siphon, for aqueducts.

ordinary industry of the people has supplemented the shortcomings of an inhospitable region. At Vinaroz and Benicarló the irrigated land comprises nearly 2500 acres. There is no river or canal, and the water is procured entirely from 500 or 600 wells with *norias* or wheels. The cottages of the labourers, surrounded by fruit trees, are built by the side of the *norias*; and the water is led from the wells, by numerous small channels, to irrigate the fields

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XII.

MODERN WORKS OF IRRIGATION

LIST OF AUTHORITIES ON THE SUBJECT OF IRRIGATION IN EASTERN SPAIN

ALTHOUGH the works of Arab origin, which I have endeavoured briefly to describe, are by far the most important and interesting, it must not be supposed that the Spaniards have altogether neglected the important subject of irrigation, in modern times. It has been seen that they have collected the immemorial usages handed down from Moorish times, and embodied them in printed or written Irrigation Ordinances; and that, in several instances, they have improved or enlarged the ancient works. Nor are purely Spanish works wholly wanting. Such are the canals in Aragon and Catalonia, the works of irrigation on the Tagus at Aranjuez,* and those in progress in General Concha's colony near Malaga. A Company is also projected, for the irrigation of the valley of the Tagus above Aran-

* Constructed by Charles V. It is to this irrigation that the growth of the splendid elms, brought from England by Philip II, is due See *Evelyn's Sylva*, Book iii, cap 7

juez. The magnificent works for supplying Madrid with water are partially used for irrigating the vegetable gardens in the environs of the capital, and cannot properly be passed without notice. These works, called the *Canal de Isabel II*, were sanctioned in the year 1851. The water is brought from the river Lozoya at a distance of thirty-six miles north of Madrid, where there is a massive masonry dam built across the river, and resting on the cliffs which rise up on either side. A lake several miles in length is thus formed in the mountains. A tunnel conveys the water from the lake, and it flows across the intervening country in a channel requiring forty-one tunnels, twenty-seven aqueducts across valleys, and six siphons. The great deposit outside Madrid is of granite, and thence the water is conveyed to all parts of the city in pipes passing along spacious tunnels. I have to thank the engineer of these works, Don José Morier, for his kindness in showing me over them, and at the same time to express my admiration at their completeness, and at the ability which has been displayed in their construction

The Spaniards are also justly proud of their legislation on the subject of the use of water. In August 1866 a bill, which had passed the Cortes, was sanctioned by the Queen and became law; containing a complete code on all subjects relating to the use of, the property in, or the dominion over water, whether of the sea, of rivers, springs, wells, or from rain. This code, while ratifying all existing rules and privileges, has been carefully drawn up with a view to clearing

up doubts, simplifying applications for concessions, and lessening the chances of litigation. It is the result of much careful and deliberate consideration on the part of a special Commission, which was appointed some ten years ago, to prepare a project with a view to legislation

In conclusion, I have to add a list of works, which may usefully be consulted, on the subject of irrigation in the eastern valleys of Spain, and on the history and topography of the irrigated regions

1.

"*Historia de la dominacion de los Arabes en España, por el Dr Don José Antonio Conde Paris*, 1840". A confused mass of translations from Moorish chronicles, but containing the history of Murcia and Valencia during Mohammedan times.

2.

"*The History of the Mohammedan Dynasties in Spain, by Ahmed ibn Mohammed Al Makkari, translated and illustrated with critical notes by Pascual de Gayangos. 2 vols. 4to. Oriental Translation Fund*, 1840." This work, besides being valuable in itself, contains a large mass of useful and interesting information, in the notes and appendices of the accomplished translator.

3.

"*Ibn el Awran, traducido por Banqueri. Madrid*, 1798." The Arabic and Spanish texts are given in parallel columns. This is a most interesting Moorish work on agriculture. It has been translated into French by Clement Mulet.

4.

"*Discursos Historicos por Cascales: fol. Murcia,* 1604." A local history of Murcia.

5.

"*Historia de la dominacion de los Arabes en Murcia, por Don Felix Ponzon Cebrian.* Palma, 1846."

6.

"*Memoria sobre los riegos de la huerta de Murcia, por Don Rafael de Mancha., Murcia,* 1836." An account of the system of irrigation in the garden of Murcia.

7.

"*Historia de la ciudad de Orihuela, por F. Martinez.* 1612."

8.

"*Memoria sobre los riegos de la huerta de Orihuela, por Don Juan Roca de Togores y Albuquerque.* 1831." An excellent treatise on the irrigation of Orihuela. It is also printed in the second volume of Jaubert de Passa.

9.

"*Illice, por Juan Antonio Mayans y Siscar. 4to. Valencia,* 1771." A history of the town of Elche.

10.

"*Xativa, por Don Vicente Boix. 4to. Xativa.*" A learned and voluminous history of the town of Jativa

11.

"*Memoria sobre la huerta de Gandia, sus riegos, y productos, por Don Pedro de Lara y Meliá. Valencia,* 1831." A treatise on the irrigation of Gandia. An

abstract of it is also given in the second volume of Jaubert de Passa.

12.

"*Observaciones sobre la historia natural, geografia, agricultura, poblacion, y frutos del Reyno de Valencia, por Antonio Josef Cavanilles. 2 vols folio. Madrid,* 1795." This great work, by the learned botanist Cavanilles, is full of valuable information respecting the works of irrigation, and agriculture of the kingdom of Valencia It also contains a useful map and several plans

13

"*Historia de Valencia, por Don Vicente Boix Cronista. 3 vols. 4to* 1845."

14

"*Tratado de la distribucion del rio Turia, por Francisco Xavier de Borrull Folio Valencia,* 1831" This work, written by a patriotic and indefatigable defender of the liberties of his fellow-countrymen, contains an account of the system of irrigation in the garden of Valencia.

"*L'irrigation dans le Royaume de Valence, Jaubert de Passá.*" The French Baron, Jaubert de Passá, visited Catalonia, and the northern part of Valencia, as far as the river Xucar, between 1816 and 1819. He carefully examined the systems of agriculture and of irrigation, and this work contains the results of his investigations. He was indefatigable in collecting his materials, and has put them together with ability and judgment. His work is most interesting and instructive. It has been translated into German, Russian, and

Spanish. The Spanish translation was made by Don Juan Fiol, and was published at Valencia, in 1844, by the "Society of Friends of the Country," at whose rooms copies may be purchased. It contains numerous additions, and the texts of all the ordinances for the Valencian irrigating canals.

16.

"*Ensayo sobre el origen, espiritu, y progresos de la legislacion de las aguas, por Don Cirilo Franquet y Bertran.* 8vo. *Madrid*, 1864." The author of this work is a politician of some distinction, and was one of the Commissioners for preparing a project of law for the use of and dominion over Waters. The essay is agreeably written, and contains a general account of legislation on the subject of irrigation in Spain, from the earliest times

17

"*Coleccion legislativa de las aguas.*" This valuable collection of laws and ordinances forms a second volume to the essay of Señor Franquet. Commencing with extracts from the Fuero Juzgo and Siete Partidas, it contains the text of very nearly all the legislation on this subject that has been enacted in Aragon, Castile, or the United Kingdoms from the earliest times

18.

"*Ley sobre el dominio y aprovechamiento de las aguas, promulgada en 3 de Agosto de 1866; con observaciones para facilitar su inteligencia, por un Abogado del Ilustre Colegio de esta Corte. Madrid,* 1866." This is a copy of the law which was sanctioned last August, with a commentary by an anonymous lawyer.

XIII

GLOSSARY OF TERMS USED IN SPANISH IRRIGATION

Alami - - - A valuer, appraiser, expert. Term used in Novelda. See *Perito*.

Albara - - - A receipt for the payment of dues.

Albercon - - - A reservoir.

Albufera - - - The lake near Valencia. All salt lakes communicating with the sea are so-called. It is derived from two Arabic words meaning "a little sea".

Alcabala - - - A tax on property.

Alcalde - - - Mayor, or chief officer in a municipality

Alfarige - - - A platform outside a mill, where corn is spread to dry.

Algibe - - - A cistern.

Aljufia - - - The centre. Name of an irrigating canal in Murcia.

Almenara - - A channel for the escape of surplus water.

Almojarife - - Tax-gatherer.

Alquibla - - South. The name of canals in Murcai and Orihuela.

Arrendador - Tenant.

Avenida - - A fresh.

Ayuntamiento - A Municipality.

Azake - - - A tithe.

Azarbe - - - A drain for carrying off surplus water from irrigated land, or irrigating canals.

Azequia - - - An irrigating canal.

Azequiero - - An officer in charge of irrigation.

Azud - - - - A dam, anicut.

Azuda - - - Persian wheel

Azumbre - - - A term used in Novelda as a measure for irrigating water. Also a liquid measure equal to about half a gallon.

Baile - - - A crown officer in the kingdom of Aragon.

Bancal - - - A terrace. Small piece of cultivated land

Boquera - - - Outlet in the side of an irrigating canal.

Braza - - - Nine *palmos* (*which see*)

Brazal - - - Small irrigating water-courses, in the fields

Brenca - - - The masonry forming the sides and floor of an outlet in a canal. A sluice post

Cahizada - - A land measure in Valencia, about six acres

Campo - - - Unirrigated land Open country.

Cano - - - A siphon

Compuerta - - Sluice gate.

Contraparada - A dam.

Electo - - - An irrigation officer elected by the cultivators.

Entandar - - To establish a *tanda* or turn for irrigation.

Escribano - - Clerk. Notary.

Escurridor - - Scouring sluice.

Estaca - - - A stake.

Fagina - - - A fascine.

Fanegada - - 1·1 acre.

Fiel Repartidor - The officer who superintends the distribution of water for irrigation, in Elche.

Fila	- - - -	The unit of measurement in Spanish irrigation. It varies in different localities. The most generally received measure is a volume of water, 50 *varas* long, by a vertical section of half a square *palmo*
Fiscal	- - -	Officer representing the rights or claims of the Crown
Fuero	- - -	A law.
Gremio	- - -	A guild or association of cultivators, for the government of irrigation works.
Guarda	- - -	A guard over a canal.
Heredamiento	-	The area of land irrigated from one canal.
Hila	- - - -	*See Fila*
Huerta	- - -	Garden. Irrigated land
Jornal	- - -	Day's work.
Jovada	- - -	Land measure in Valencia, equal to six *cahizadas*.
Juez Sobre-azequiero		A judge in matters relating to irrigation.
Junta	- - -	A board. Committee.
Jurado	- - -	Jury. Irrigation officers elected by the cultivators.
Landrona	- -	Drain. *See Azarbe*.
Malecon	- - -	Quay. Dike.
Manantial	- -	Spring.
Marco	- - -	The dimensions of an outlet in a canal.
Margen medianero		Boundary line between two fields on the same level.
Margen callada		Terrace wall, or boundary line between two fields on different levels.
Martava	- - -	Turn for irrigation. Term used at Novelda. *See Tanda*.
Merancho	- -	A drain. *See Azarbe*.
Mondar	- - -	To clean out a canal.
Noria	- - -	A Persian wheel.

Palmo - - -	8·346 inches.
Pantano - - -	A tank. Artificial lake.
Parada - - -	Mounds thrown up to retain water in small channels, to irrigate a field.
Partidor - - -	An outlet in the mother-canal for distributing water. Channel flowing from an outlet.
Perito - - -	A valuer. Experienced person who is consulted in irrigation matters. *See* Alami.
Presa - - - -	A dam.
Pulgada - -	A Spanish inch, 36 to a vara (*which see*).
Quigero - - -	Slope of a canal.
Rafa - - - -	Operation of stopping the water in a canal, by a temporary dam, so as to raise it to the level of an irrigation outlet.
Rambla - - -	A ravine. A dry bed of a torrent.
Regante - - -	A cultivator receiving water for irrigation
Regidor - - -	Irrigation office.
Regolfo - - -	Flow of water against the ordinary current
Repartidor - -	Distributor of water.
Riego - - -	Irrigation.
Sifon - - -	A siphon.
Sindico - - -	Syndic. Recorder. Irrigation judge or officer.
Sobreceguiero -	Irrigation judge.
Surco - - -	A furrow.
Tablacho - -	Flood gate. Sluice gate.
Tablon - - -	,, ,, ,, ,,
Tahadil - - -	Adjustment. Compounding for a tax.
Tahulla - - -	Land measure in Murcia and Orihuela. ·27 of an acre.
Tajamar - - -	Masonry structure in the bed of a canal, to divide the water into two channels.

Tanda - - - Turn for irrigation. See *Martava*

Tribunal de las aguas The Court of Irrigation Officers for the trial of all offences relating to irrigation, at Valencia.

Tioneta - - - The place where the right to irrigation (the *tanda*) is sold, at Elche and Novelda.

Vara - - - - A Spanish yard, equal to 32·89 English inches.

Veedor - - - Overseer of irrigation works. Valuer or appraiser.

Vega - - - - A fertile plain, or valley.

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